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THE 25 DE MAYO.

THE steam trials of the 25 de Mayo, which have just been completed, mark a distinct step in the speed attained by fast cruisers. This vessel, which is of the twin screw protected cruiser type, has been constructed by Sir W. G. Armstrong, Mitchell & Co. for the Argentine government, who may well be congratulated on the acquisition of such a splendid specimen of naval engineering. She is somewhat larger than the Piemonte, which was built by the Elswick firm for the Italian government, and which, as our readers will remember, on her completion about eighteen months ago, herself broke the speed record. The dimensions of the 25 de Mayo are as follows: Length between perpendiculars, 325 feet; breadth, 43 feet; mean draught, 16 feet; displacement, 3200 tons.

The machinery and vital parts of the ship are protected by a strong steel deck extending throughout the whole length of the ship, such as is usually adopted in this class of vessel, but of unusual strength, being 4½ inches thick on the sloping sides and 1¾ inches thick on the horizontal portions. Above this deck is constructed a deep raft body divided into numerous water tight compartments, which may, if desired, be filled with cork or other water-excluding material, thus insuring buoyancy to the ship even if riddled in action.

The vessel is armed largely with the formidable rapid-firing guns recently introduced by the Elswick firm, arranged to have the largest effective arc of training. On the forecastle, firing right ahead and to 45 deg. abaft the beam on each side, is a 21 cm. breech loading gun. A similar gun is mounted on the poop firing right astern, and with an arc of training equal to that of the forecastle gun. On the upper deck in sponsons along the sides are arranged eight 12 cm. rapid firing guns, the foremost pair being capable of firing right ahead to 45 deg. abaft the beam, the two aftermost having a corresponding stern fire, and the four midship guns an arc of training of 120 deg. broadside fire.

The minor armament has also been well considered, and consists of twelve 3-pounder rapid firing guns and twelve 1-pounder rapid firing guns, distributed in the most effective manner, six of the 1-pounders being mounted in military tops on the two masts.

The modern locomotive torpedo has not been overlooked, for the vessel is provided with three 18 in. torpedo guns, two of them training on the broadside and one fixed in the bow. The machinery was constructed by Messrs. Humphrys, Tennant & Co., of London, and consists of two sets of four-cylinder triple-expansion engines and four double-ended boilers, each set of engines and each pair of boilers being placed in separate compartments.

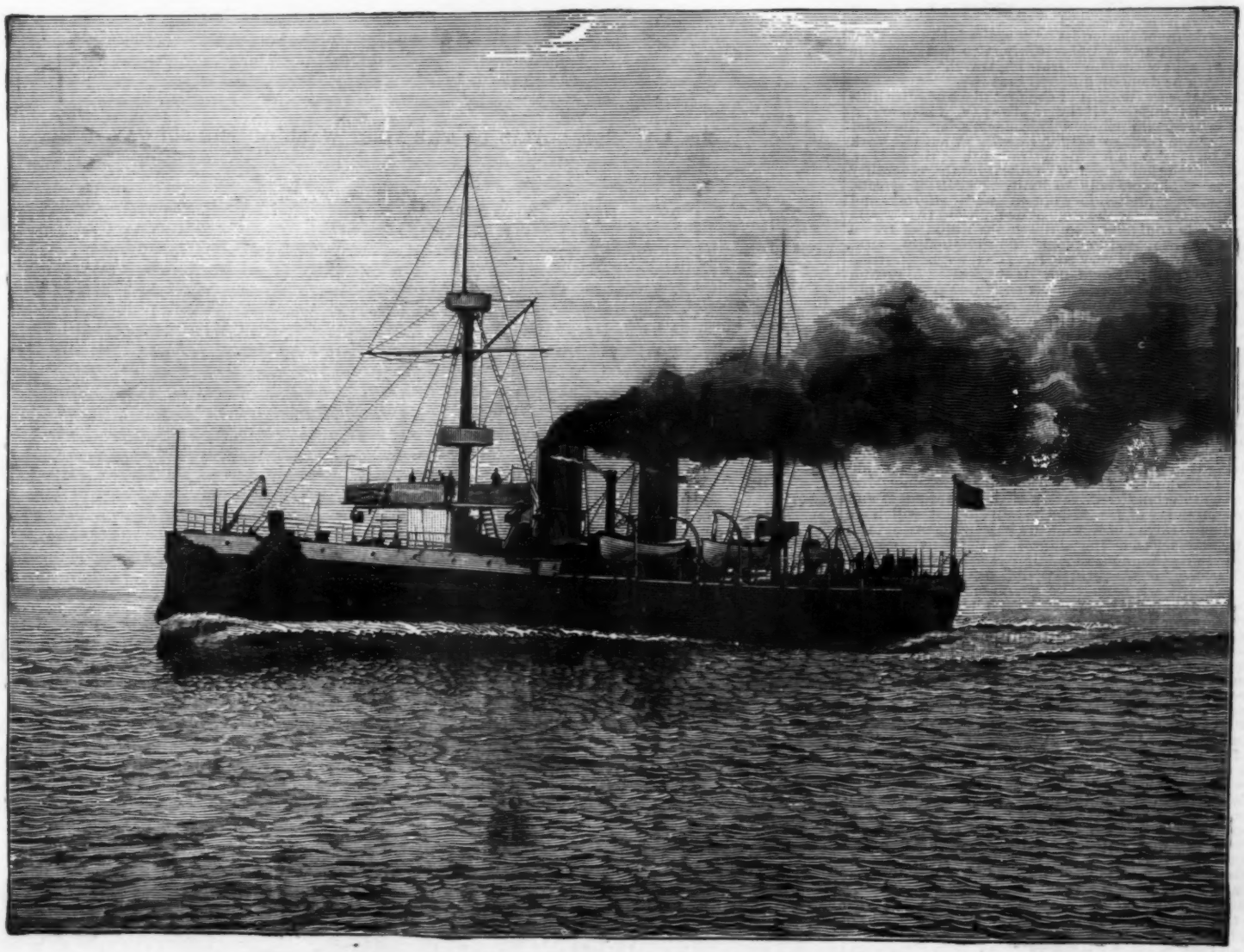
The steam trials which have just taken place on the Admiralty measured mile off the mouth of the Tyne were attended by a commission of Argentine officers, including Captain Spurr, Captain Garcia, Captain Ramirez—commander of the vessel—and Colonel Warren on behalf of the Argentine government; Mr. P. Watts, designer of the vessel, on behalf of the Elswick firm, and Mr. Robert Humphrys representing the constructors of the machinery.

At the official trials a run of six hours' duration was made with natural draught, in accordance with Admiralty conditions, and while this trial proceeded, a number of runs with and against the tide were made on the Admiralty measured mile, the results of which demonstrated that a speed of 21·237 knots per hour had been maintained during the whole six hours' run. During this trial the mean power developed was 8,700 indicated horse power. At the forced draught trial, which was made at the close of the day, when the fires were in bad condition and the stokers tired, the mean speed attained was 22·43 knots per hour, and the mean power 13·800 indicated horses. Throughout the day the engines worked in a most satisfactory manner, without a hitch of any kind, and the Argentine commission were highly delighted with the performance of the ship.

The vessel carries 300 tons as her normal supply of coals, but bunker capacity is provided for 600 tons. With the full supply of coal she could steam about 2,000 knots at full speed, natural draught, while at the most economical speed she could steam from 9,000 to 10,000 knots. We are indebted to *The Engineer* for our illustration and the foregoing particulars.

USE OF WATER POWER AND ELECTRICITY IN TUNNELING.

THE new railway which is to connect the Argentine Republic with Chili will necessitate the boring of eight tunnels through the Andes mountains of a total length of 15,375 m., or nearly ten miles. These tunnels, in whose construction water power and electricity are to be largely employed in a novel form, have already been commenced at 26 points. Since August last a cataract of the Juncalillo river, which has a fall of nearly 600 ft.,



THE NEW ARGENTINE CRUISER 25 DE MAYO.

has been made use of to supply the power in carrying out the boring operations in the tunnels of Portillo, La Calavera, and La Cumbre. The Portillo tunnel takes a serpentine course through the massive rock, and its upper end emerges at the mountain side, 450 ft. above the entrance. The water of the Juncalillo cataract is conveyed through steel pipes of half a meter in diameter for the distance of about a mile to the Juncal station. The boring machines employed in these three tunnels required a force of 1,000 horse power to drive, and this is obtained by converting the water power into electricity. The water which is carried through the steel pipes is made to set in motion ten turbines, each of 80 horse power, which are connected with the electrical machines. The electricity thus produced is conducted through strong insulated copper cables to Juncalillo and Calavera. From Juncalillo air pressure machines are also supplied in the serpentine tunnel leading up to Portillo. From Calavera four 80 horse power dynamo machines generate the electricity for the Cumbre tunnel, where six borers, all working at the same time, are driven by eight air pressure engines. On the Argentine side of the mountains another cata-

ract near Navarro, has been similarly used for driving four turbines, each of 80 horse power. Owing to the distance of the western smaller portion of the Cumbre tunnel, water power cannot there be employed, and the borings are being carried out by hand. Wherever water and electricity can be used, the boring operations are performed, it is estimated, fully four times as rapidly as they would be by hand. The cost and progress of the borings accomplished by this novel application of water power and electricity cannot at present be estimated, but the figures, which will be made known on the completion of the undertaking, can scarcely fail to prove of considerable interest to the engineering profession.—*Engineering.*

THE METROPOLITAN RAILWAY OF PARIS.

WHATEVER be the decisions made on the subject of the definite direction line of the Metropolitan Railway of Paris, the railway will consist, at all events, of a subterranean and an aerial part. We have demonstrated how this solution, the only one compatible, moreover, with the financial conditions, was necessitated at the establishment of the first system.

As regards the aerial part, on the surface or on viaducts, the art of the engineer meets with no difficulty. Our builders, who have laid the bases of the metallic construction, and who, according to the vigorous expression of Mr. Eiffel, in his inaugural address to the Society of Civil Engineers, have covered the entire world with the productions of their talent, cannot meet with any serious difficulty in crossing, by viaduct, any section whatever of the Paris Metropolitan. The perfection of the solutions adopted, whatever be the locality, is certain.

The question of this railway required a special study, which has been made, and of which, in the first place, we shall give the main points conformably to the proposed projects of the eminent engineers who will be charged with the execution.

If the desire of the public be consulted, the essential condition at Paris is the following: to carry out the work without entirely interrupting travel.

This can be done by different means.

The engineers thought in the first place of substituting for the surface of the roadway (as was done at London at certain points) a flooring covering, the latter entirely from right to left, and under which the work might be carried on for the entire width of the section. This is a solution much too radical in the generality of cases, applicable only to limited widths of streets, and requiring preliminary operations of shoring, and subsequent ones (at the time of demolition) that would be precisely equivalent to the interruption of travel that it was proposed to avoid. This method of work, moreover, would be very costly. It cannot be asserted, however, that it would not be applicable in certain special circumstances, but these would certainly be the exception, and not the rule. We shall say as much of the excellent process of tunneling with the Beach shield, which will probably be employed, but as a special means. This shield has performed excellent service in certain public works. The Berliner system that we have already described is also based upon the use of it. Wherever we find unstable, wet or inundated earth, this shield is capable of rendering great service; but we cannot think, at the beginning, of generalizing a process of this importance, which would be necessarily onerous for the constructors. Before putting it in practice it is well to wait until the difficulties of which it gives the solution are reached.

In the interim, the engineers of the government and city and those of the Eiffel establishment will have the time to introduce into it the improvements in form and resistance that the subsoil of Paris may necessitate. In our opinion, such improvements will be simplifications, for the greatest difficulties in traversing the soil of Paris cannot be compared to those that foreign engineers have met with under the Hudson and Mersey rivers at great depths, with dangerous pressures and infiltrations. The word "tunnel" applied to the Paris Metropolitan is, in the generality of cases, very pretentious and unnecessarily alarming. Can we apply the name to the covered subways easily accessible at all points, capable of aeration, easily excavated and rendered wholesome, that we find in the projects of the Company of the North and of the Eiffel establishments? Such excavations are not very deep, and in nowise enter the bowels of the earth, and they are daily being made at all points of Paris for the construction of blocks of houses, etc.

We are no longer in the period in which the foundation work of the Opera House necessitated a labor of Penelope based upon the drying of a subterranean stream. The art of the engineer has made great strides since then, and on this same ground, so expensive to elaborate, there have been built the Magasins du Printemps, safely and rapidly, by means of compressed air. Those timorous minds that are obstinate in applying to the future work on the Metropolitan the lessons of an honorable but primitive past are ignorant, in truth, of all that has been done in this line in France and foreign countries for some years past. In the matter of public works, nothing is now turned topsy-turvy. The working points are prepared and arranged in a certain manner without giving any anxiety to the nearest neighbors. Timorous people are twenty years behind the age.

One of the most important of works, cutting through streets in which there was an extremely large traffic, has just been executed in Paris without any one having scarcely perceived it. We refer to the suppression of the surface crossings of the Belt Railway. There was here, at all the crossings, not only a great rush of pedestrians and vehicles, but an uninterrupted passage of railway cars. No interruption of the travel occurred, and no accident was recorded.

It is precisely an analogous method, rational and certain, that the engineers of the Railway of the North and of the Eiffel establishments propose to put in operation for the execution of the Metropolitan system. It consists in a mathematical division of the work, reducing the travel without even interrupting it.

In principle, the programme is reduced, as is so often done in street work, to the isolation, for an extent varying from 200 to 250 yards, of about a third of the roadway which will form the working point, the two other thirds remaining entirely free. At each of the points of operation the work will be proceeded with by subdividing it into five successive and distinct periods, as our figures show: (1) The construction, in a timbered excavation, of one of the sides, with the springers of the vault, in masonry (Fig. 1); (2) construction of the other side under the same conditions, after a temporary re-establishment of the roadway above the first wall (Fig. 2); (3) construction of the arch upon natural earth and re-establishment of a provisional roadway (Fig. 3); (4) underground execution of the remainder of the work, excavation and construction of the invert (Fig. 4); (5) finally, after ramming the filling, the reconstruction of the roadway and putting it in order.

It is certain that in this mode of methodical attack a third of the road only will be closed to travel, and that by sections. As for the travel of pedestrians, that will remain constantly free.

The moving and reconstruction of the sewers will proceed on the same system.

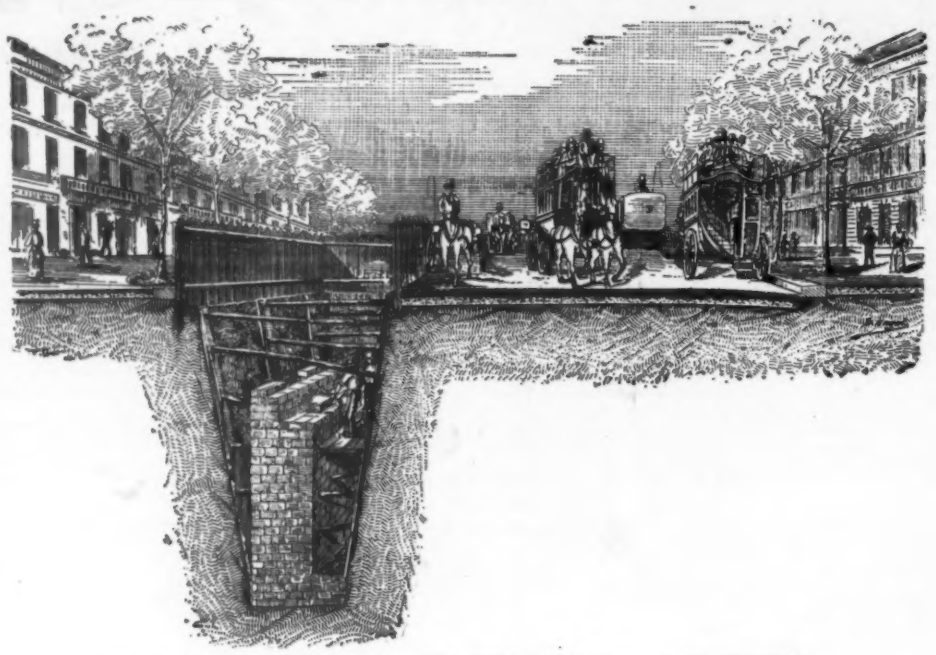


FIG. 1.—CONSTRUCTION OF THE FIRST WALL OF THE SUBWAY.

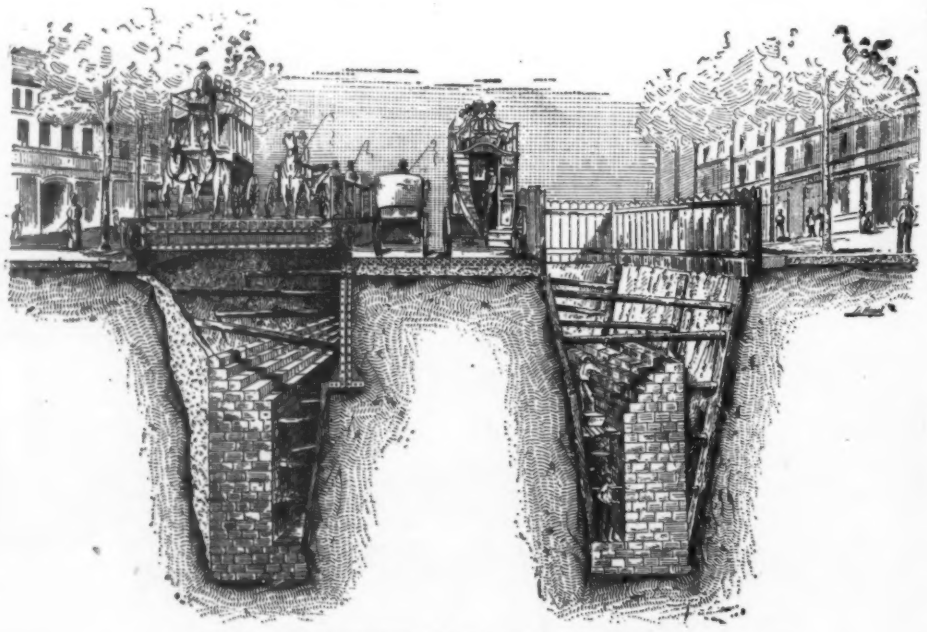


FIG. 2.—CONSTRUCTION OF THE SECOND WALL.

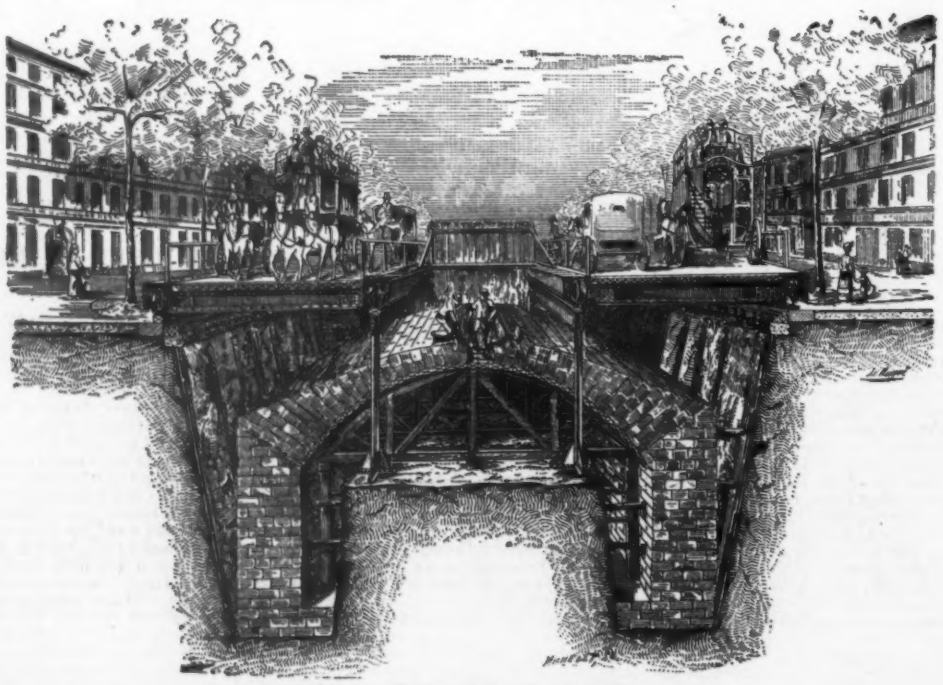


FIG. 3.—FINISHING THE VAULT.

The amount of excavated material to be removed is not large, and the disinfecting of it during the course of the work will be easily done by means indicated by hygiene.

Throughout the extent of the central line, in Rivoli Street, it will be easy, by means of central galleries debouching at the Seine, to begin work at several points at once, at the same time that the branch of the large boulevards is attacked at its southern extremity. This

FIG. 4.—EXCAVATION OF THE EARTH, AND CONSTRUCTION OF THE INVERT.

can be attacked at the same time at its northern extremity near St. Sebastian Street, while very likely there will already have been constructed the metallic part that is to extend from this same street to the Vincennes station, or, if need be, to that of Lyons, by joining it by rail, so that the carrying away of excavated stuff and the arrival of materials will be continuous.

The branch of the boulevards might also be begun at two intermediate points, if, as is probable, the Company of the North succeeds in due time in constructing the prolongation of its lines toward Opera Place and the Halles.

Upon the whole, by the professional man, and it is a confidence that the public ought to share in, there is no apprehension to be felt on the subject of the obstruction to travel that the construction of the Metropolitan may cause, no more than in what concerns the bringing of materials and carrying away of excavated stuff.

The broad lines of the work are drawn, and will be but slightly departed from. It is very evident that the selection and adoption of processes of construction will, in measure as the work advances, have to be agreed upon between the engineers of the grantees, those of the management and those of the city of Paris; but we may now be assured (and this is the formal opinion of our most competent engineers) that the agreement upon these technical ways and means will be easily effected among all those who will have to participate in this great work, either as managers or executors. The construction can and should be sure, economical, and rapid, without any inconvenience to the inhabitants of Paris.—*Abstract from Le Genie Civil.*

THE MONTE GENEROSO RAILWAY.

AT the present rate of progression there will soon be hardly a mountain in Switzerland which has not its own private particular railway running up to its summit. Monte Generoso, a spur of the Alps lying between the lakes of Lugano and Como, is the last which has lowered its crest to the locomotive. This mountain, which is sometimes called the Rigi of Italian Switzerland, is 5,560 ft. from the level of the sea, and combines in a wonderful way the charms of an Italian landscape with the grandeur of the Alps. The railway, which is a cog wheel line on Abt's system, was begun about eighteen months ago, and was completed in May last.

Starting from the village of Capolago, at the southern end of Lake Lugano, the line rises with a steep ascent for about two miles, until it reaches a perpendicular precipice. This is pierced by a loop tunnel which emerges at the first station, San Nicholao. Two smaller tunnels are traversed ere the train arrives at the middle station of Bellavista, where is situated, on a magnificent mountain terrace, the Monte Generoso Hotel, built by Dr. Pasta in 1854. There are still one or two more stations to pass through before the engine with a last strenuous effort climbs the steep slope just before the summit, known as the Vetta. From the top, which is only about ten minutes' walk from the terminus, a grand view is obtainable over Italy, Switzerland, and the Tyrol.—Our illustrations are from drawings by T. Nieriker, Zurich.—*The Graphic.*

THE LEBEL AND MANNLICHER GUNS.

THE principal part of the German gun, that which distinguishes the weapon selected by the staff office of Berlin from our Lebel gun, is what is called the "charger." Instead of, as in the Lebel gun, storing eight elongated cartridges, one after another, under the barrel of the gun, and which, by means of a special mechanism, place themselves in turn opposite the breech end, the German gun (called the Mannlicher gun, from its inventor, and adopted for the Austrian army) is provided with ammunition by means of a movable charger containing five cartridges, which is placed by hand in the space formed to this effect, and which is renewed as soon as the five cartridges that it contains are exhausted.

The special arrangement of this charger, its position in the weapon, and the method of filling it are explained in Figs. 1 and 2.

Fig. 2 represents the charger itself. It is a very light steel plate box, rendered still lighter by the formation of a circular aperture on each side. The upper and lower edges are recurved, in order to keep the cartridge in place. The box is provided with a rib that engages with the groove of the cartridges and serves as a guide to them. The German cartridge, in fact, is constricted at its lower extremity.

When it is desired to load the German gun, the soldier takes from his shooting pocket a charger provided with five cartridges, and introduces it into the magazine case of the weapon. The charger is kept in place by an elevator which carries in front a piston with a spiral spring. The role of this elevator is to bear, through the intermedium of a channel, against the lower face of the charger, and thus lead the cartridges one after the other opposite the concavity of the movable head. Behind is seen the stop of the charger actuated by its spring, the function of which is to keep

The Highest Point to which the Railway Ascends

The Tunnel of San Nicholao

THE STATION OF VETTA
At the Summit of the Mountain

THE NEW SWISS RAILWAY ASCENDING MONTE GENEROSO.

the charger in place in the magazine and prevent it from rising.

From the brief explanation given, the role of the charger is easily understood. It is not, however, the sole interesting innovation of the German weapon. The special arrangement of the barrel of the Mannlicher gun is, in fact, a most original and curious one. Contrarily to our Lebel gun, which has but one barrel, and that entirely exposed, and always in contact with the atmosphere, the German gun has a double barrel, composed of the barrel itself and of a concentric metallic envelope, a sort of protective jacket for the barrel, properly so called. Fig. 1 shows us this arrangement, which, we believe, is now employed for the first time in fire arms.

According to its inventor, the object of the external metallic jacket is to protect the barrel against external shocks, against distortions of the stock, and against

FIG. 1.—NEW GERMAN GUN.

1. General view. 2. Arrangement of the double barrel. 3. Details of the firing mechanism.

the flexions produced by the movements of the saber bayonet. Besides, it must protect the hands of the soldier from contact with the barrel, which, during rapid firing, is raised to a very high temperature.

Screwed by its posterior extremity to the head of the breech box, the external jacket of the barrel leaves a space between it and the barrel throughout its whole length, and terminates at the muzzle in a constriction or channel into which the barrel passes by slight friction, so that it can expand freely in the direction of its length.

The metallic jacket, forming a double barrel, and the charger constitute, as may be seen, the two interesting innovations of the Mannlicher gun. The barrel, which is 7·9 mm. in internal diameter, has four grooves, running from left to right, and the pitch of which is 24 cm. in length. The total length of the gun is 1·35 m.—5 cm. less than the Lebel. Its weight, the magazine not charged, is 5·8 kg. It is therefore a little lighter than the French gun. The velocity of the ball, at 25 m. from the muzzle, is 620 m. and its maximum range is in the neighborhood of 5,800 m. at an angle of 32°.

According to data furnished us by German documents, and particularly by a very interesting pamphlet published at Hanover, the effects of penetration of the Mannlicher gun are as follows: At a distance of 100 m. the ball perforates a fir board 80 cm. in thickness; at 400 m. a 0·45 m. board; at 800 m. a 0·25 one; and at 1,800 m. the projectile traverses a board 0·05 m. in thickness. At these same distances, the ball buries itself 0·9 m., 0·5 m., 0·35 m., and 0·10 in a pile of sand. Up to a distance of 300 m., the ball traverses a 0·007 m. iron plate. A 0·008 m. steel plate of excellent quality receives insignificant indentations up to 50 m.; beyond that distance, the balls no longer leave any trace. From these various experiments our neighbors across the Rhine conclude that thin brick walls are but an incomplete protection against the fire of the Mannlicher gun, several shots striking at the same place having finally traversed them. Parapets of earth should have a thickness of at least 0·75 m. in order to guarantee them against the fire of the musketry.

It remains for us to describe the cartridge itself, the weight of which is 27 grammes, and the length of which is 82 mm., instead of 29 grammes and 75 mm., the weight and length of the Lebel cartridge. The bullet is formed of a steel shell covered with a deposit of German silver, or entirely of German silver, in which is compressed a core of hardened lead. It weighs 14·5 grammes and is four calibers in length. The cartridge shell has no flange. It is the neck of the shell that limits the introduction of the cartridge into the chamber. Upon the circumference of the base, there is a groove for the jaws of the extractor (Fig. 2). The charge is 2·5 grammes of new powder.

The new cartridges are put up in packages of five per charger. Three chargers are introduced into a thin cardboard packet divided into three compartments. The soldier receives his ammunition in full packets, which he introduces into the cartridge boxes. He places two packets in each of the front or six in each of the back boxes; a total of 150 cartridges, weighing 5·3 kg. It is not till he arrives at the skirmish line that the man removes the charges from the packets. However detailed a description of the German gun might be, it would not be complete did we not add a *resume* of the judgment that has been passed upon its operation, and principally upon the merit of the innovations that it has inaugurated in the construction of portable weapons of war, and what is best calculated to surprise us—the establishment of the double barrel, the chief function of which is to remedy the progressive heating of the weapon in rapid firing. That such heating occurs no one now doubts. In three recent experiments in continuous firing it was found that after twenty or twenty-five cartridges the soldiers had to stop firing unless the precaution were taken to put duplicate guns in their hands.

Does the double barrel with an intervening cushion of air truly remedy the progressive heating of the German weapon? Such is the question recently asked by one of the most distinguished military specialists, already known by his numerous studies upon portable arms, Dr. Hebler. The *Revue Militaire Suisse* has published the result of Dr. Hebler's experiments and its conclusions are wholly to the disadvantage of the new arrangement. Far from preventing the rapid heating of the barrel, the addition of the jacket serves, on the contrary, only to greatly increase the elevation of the temperature. In a rapid firing of from 80 to 100 shots, the temperature of the barrel would thus rise to 480°, or even to 600°. What is still worse than one's inability to hold his weapon momentarily, the grooves of the latter would then be completely put out of service, and that, too, whatever be the nature of the covering of the projectile and the profile of the grooves.

So severe a conclusion concerning a weapon that has been the object of the solicitude of men of war, and whose value it would be unjust not to recognize, demands a few explanations. These are based entirely upon the fact that the barrel, when it is doubled by an external tube, and through that is surrounded with a cushion of superheated air, becomes much more rapidly heated than a simple barrel, and so much the more quickly in proportion as it is forcedly lighter than in the case of a single barreled gun, the weight of the weapon not having in any case to be increased. Dr. Hebler has found that at every shot fired the barrel of a gun provided with an external tube becomes heated from 5·5° to 6°. In the case of a rapid fire of 80 shots, the temperature of the barrel of the German gun would therefore be 480°, as we have above stated. In a firing of 100 shots, it would reach 600°!

The results to which Dr. Hebler has been led are, then, if we are to trust them, and we see no reason to do otherwise, the condemnation of the German gun with double barrel—a condemnation so much the more justified in that at these extreme temperatures the new smokeless powders would produce pressures in the interior which might quickly lead to the bursting of the weapon in the hands of the soldier.

According to German works, it is certain, moreover, that the two powders designed for filling the cartridges of the Mannlicher gun (the Rottweil powder or that of Spandau called follicular powder) are absolutely inferior to our Vieille powder. In truth, they disengage very little smoke and are perhaps irreproachable as regards accuracy of firing and range, but they have the disadvantage of leaving much solid residue after the firing, and, as a consequence, quickly foul the gun itself.

We now come to the magazine, or rather the charger, which, it is said, increases the rapidity of firing. In all sincerity, it is difficult to pass judgment upon this side of the question, inasmuch as we have not at hand, as we have for the double barrel and the powder, precise experimental data in which we can confide. What we can, however, deduce from what we have already set forth is that our Lebel gun cedes in nothing, as regards ease of handling, precision of firing and security of operation, to the Mannlicher gun just described. As regards mechanism, both present visible progress upon the weapons that they have succeeded. As for the "practical" results expected of them, the future alone will be able to enlighten us upon this subject and to tell us with certainty to which of the two victory will remain.—*La Nature.*

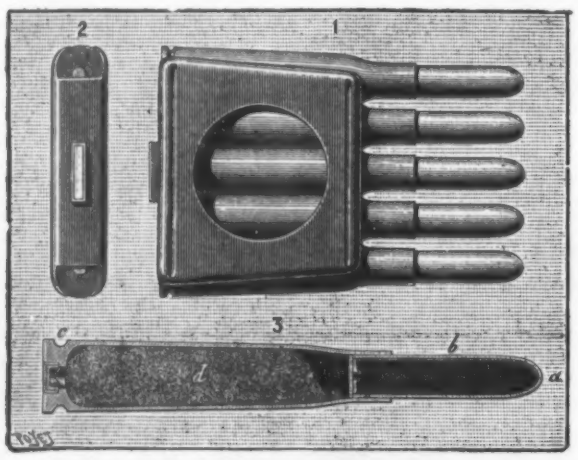


FIG. 2.—NEW GERMAN GUN.

1. General view of the charger. 2. Side view of the same. 3. Cartridge, actual size: *a b*, bullet; *c*, groove; *d*, powder.

THE CENTRAL TOBACCO FACTORY IN CONSTANTINOPLE.

THERE is no luxury which is more universally used and enjoyed than tobacco. It has its devotees among all peoples. Turkish tobacco bears the same relation to the other grades of this plant that Mocha does to the various other kinds of coffee, and therefore we think that a description of the manufacture of tobacco in the "Central Factory," at the Golden Horn, will not be unwelcome.

The buildings of the main factory of the Turkish Tobacco "Regie" are in the Techubali quarter of Stambul, and since its incorporation in the year 1884—under the name of "Regie cointéressée des Tabacs de l'Empire Ottoman"—it has possessed the sole right to manufacture and sell tobacco in this empire. Unquestionably the finest and best tobacco in the world is raised in the Turkish empire, and the law against the importation of foreign tobacco into the country will probably act, not only financially, as desired, but as a precaution against the deterioration of the home product. Before the institution of the monopoly there were small factories in all the large cities of Turkey, as there are still in all countries where there is no monopoly, and although the managers of these concerns may not have possessed the most thorough knowledge of the business, still they accomplished very good results under the pressure of competition.

When the "Regie" (which is formed of Englishmen, Frenchmen, Germans, and Austrians) took charge of the business, the old factories vanished and larger ones were erected in Constantinople, Salonica, Smyrna, and Samsoon. Besides these the company maintains small local factories in many of the more remote districts; but their largest establishment is the one in Constantinople, which is perfectly equipped with all the most modern improvements. This is due largely to its active director, Mr. G. Klarie, who has had ample experience in the factories of Austria-Hungary and Romania. He had views of the workrooms taken by the local photographer and put into an album which was sent to the Sultan. Our illustrations were taken from this album.

The first step in the manufacture of tobacco is, of course, the careful sorting of the leaves, which is done by the "tutundschis," men who have worked all their lives in tobacco. In Europe this work is generally done by thoroughly trained women, whose labor is cheaper; but in Turkey provision had to be made for the workmen who were thrown out of employment when the old factories gave up business; and furthermore, Turks believe that only the experienced "tutundschi" understands the sorting of tobacco. Experience shows that the most favorable results are obtained from their work.

After the tobacco leaves have been sorted they are mixed by experts, and the finest grades are cut by hand, the rest by machines. There are about 25 so-called "havanes" for the hand cutting and 30 machines of English construction for the machine cutting. The amount of work done by one machine depends on the way in which the tobacco is cut. The coarser the cut, the greater the quantity treated. Tobacco which is to be used in the interior of the country is generally cut very fine. The factory is arranged so that it can cut from 30,000 to 32,000 pounds daily, but its average daily work amounts to only about 24,000 lb.

After being cut the tobacco is taken to the cooling room, where it must lie for some days. Later it is weighed and packed or made into cigarettes. The finer grades of tobacco are packed in tin or pasteboard boxes containing 25 grammes or less and the commoner grades in pasteboard boxes containing 100, 250, or 500 grammes. One room is devoted to the filling of these boxes, and here from 1,000 to 1,500 lb. is daily packed in boxes, which have been previously furnished with labels.

Three roomy apartments, in which 400 women work under proper direction, are used for packing the tobacco of the lower grades in packages of 25 grammes (the packages for the military contain 22½ and 31½ grammes). The packages are made without sealing

wax, simple bands being used for fastening them, which greatly lessens the labor and expense of the operation. The average production is 400,000 daily. After the packages are completed their weight is carefully tested by a special machine, which is driven by steam and which automatically drops the packages of the correct weight in the middle while those which are too light or too heavy fall to the right or left. Two days later, when the bands are perfectly dry, the packages are packed in boxes, each of which contains 100 pounds. The boxes are then removed to the store rooms of the factory.

All the finest cigarettes are made by hand, the wrappers being prepared by machines of the latest pattern, which are operated by steam, and each of which produces from 40,000 to 50,000 wrappers daily, without the use of any adhesive material, the parts being simply pressed together mechanically.

When the wrappers are ready, they are provided with mouth pieces and then filled by hand. This work is done in two large rooms, in one of which from 50 to 60 lads work, while in the other there are about 200 cigarette girls with their helpers; 400,000 to 450,000 cigarettes are filled daily.

They are then trimmed and packed in boxes—pasteboard boxes each holding 25 and tin boxes holding 100, 250, and 500 each—and these boxes are finally packed

1. Weighing the tobacco and filling the packages. 2. Manufacture of cigarettes by machines. 3. Filling boxes with tobacco. 4. Making cigarettes by hand. 5. Packing cigarettes for exportation.

THE CENTRAL TOBACCO FACTORY IN CONSTANTINOPLE.

in packages containing 500 each. The commoner grades are made by machines which are driven by power. Each one of these machines (to which the tobacco is fed by one girl) turns out from 12,000 to 15,000 daily. It is surprising to see how many different operations these machines perform. They first draw paper of the necessary length for a cigarette from a roller, then cut it off, roll it up, wipe the edge with gum, stick the wrapper together (some of the machines work without gum) and then place it on a carrier on which the wrappers move upward in a row, and finally the complicated machine fills one wrapper after another automatically and lays the completed cigarettes in boxes, each of which holds 1,000. They are afterward packed the same as the hand made cigarette.

The factory at Constantinople also produces goods which are designed entirely for export, and these goods are handled in separate rooms by a different force of workers—about 100 girls and from 30 to 40 men.

The Turkish company has trade with all parts of the world, but its chief customers are Germany and England, then follow Italy, Austria-Hungary, France, Switzerland, and all the other countries of Europe, America and Australia. It has agents in most of these countries.

Cigars are not made in Turkey, for, as has been already stated, the importation of foreign tobacco is prohibited and the leaves of the Turkish tobacco are small and of a golden yellow color, so that they cannot well be used for wrappers, though they are excellent for fillers. Good snuff is made at this factory, and also at Janina.

Buildings of this factory include a well arranged machine shop, a foundry, a place for grinding the knives, a tin box factory provided with the newest machines, and a carpenters' shop for making cases. Nothing is lacking that can be needed in the most complete tobacco factory. The raw material, as well as the finished products, are moved from one story to another by steam elevators and on trucks running on rails. A cable road run by steam carries the goods to and from the shore. The whole establishment is heated by steam, is provided with a water supply, and has a fire department of its own. The central tobacco factory employs about 1,500 hands, about 400 of whom are men and boys (Turks, Armenians, Greeks, etc.), and about 1,100 women and girls, the greater number of whom are Israelites, the rest being Armenians and Greeks. Of course, there is not a single Turkish woman among the employes. They have become accustomed to European order and discipline, and are well satisfied with the humane treatment and the punctual payment of wages. They have a doctor of their own and a fund for helping the sick. Each sick employe receives half pay during the first four weeks of his illness, and quarter pay during the next four weeks.

If we mention, in closing, the immense storage department for the tobacco leaves, in which there is a regular stock of 6,000,000 pounds, we will have drawn a true picture of the Turkish central tobacco factory, the development of which must be greeted with pleasure by all who are interested in the matter.—*Ueber Land und Meer.*

THE PINTSCH GAS SYSTEM.*

By ROBERT M. DIXON, of New York.

AN account of the Pintsch gas system involves a description of the apparatus (invented by the late Julius Pintsch, of Berlin, Germany) which has made the use of compressed oil gas a practical, economical, and satisfactory method of railroad car illumination. The use of oil gas for lighting cars, boats, floating buoys, etc., possesses distinct advantages over the use of a gas of lower candle power. Oil gas can practically be made of about 75 candle power, and this, after subjection to the losses due to a compression to say 200 pounds per square inch, will still be from 60 to 65 candles, while 19 candle gas, after the same treatment, will not be more than 10 or 11 candles. The use of compressed coal gas has been tried on a large scale, and under the most favorable conditions, both in Europe and America, and has been decidedly unsatisfactory. The receivers, for carrying the gas under the cars, have to be of greater size, and the charging stations must be more frequent, and equipped with expensive compressing and storage apparatus of large capacity, some six times as much city gas as oil gas being required for a given amount of light. The cost also is in favor of oil gas. This can be made and delivered to cars, according to the Pintsch method, at a total cost of less than $2 a 1,000. City gas at $1 25 a 1,000 will cost, put in cars, $2.33 a 1,000, and six times as much is required, making the relative cost as about 1 is to 8.

For manufacturing the gas and compressing it for delivery to the receivers under the cars requires a plant consisting of a gas works, naturally of small dimensions, which may be located at any available place, and pipe lines connecting them with the car yards and stations. For the pipe lines three-fourths *x* strong iron pipe is used, and if the length be great, and quick charging of cars is desired, an accumulator, from which the gas is drawn for the cars, is placed at the yard. In laying the lines no provision is needed for draining or drips. All moisture and vapors are effectively removed during the process of compression.

The gas works themselves comprise furnaces for the production of the gas, some small condensing apparatus, a plate washer, purifiers, a station meter and gas holder, together with compressors and large store holders, into which the gas is forced and held ready for delivery through the pipe lines to the cars. Each furnace consists of a setting of two retorts, one arranged above the other. At one end of the furnace, a double mouth piece connects the ends of the two retorts. The oil is fed into the other end of upper retort, and the outlet pipe for the gas is taken from the end of the lower retort just below.

The retorts are heated by a fire below them, separate from the lower retort by a firebrick wall. The products of combustion pass along the sides of the lower retorts, heating them to the proper temperature for gas making, and before passing into the chimney along the sides of the upper ones, heating them also, but to a less degree, by the heat which would otherwise be wasted.

The cleanliness of the retorts is found to have considerable influence, not only upon the amount of fuel used, but also upon the yield of gas from a given quantity of oil. In order that they may be easily cleaned, each end of each retort is provided with a cover, and an iron pan is used in the upper, into which the oil falls, serving to prevent its coming into direct contact with the hot retort, and facilitating the removal of non-volatile elements contained in the oil.

The lesser heat of the upper retort vaporizes the oil, and in this condition it passes to the lower retort, the greater heat of which serves to bring it to the condition of a fixed gas. The gas passes to the water seals located below the level of the retorts, and in the conveying pipe is placed a try cock for determining the quality of the gas that is being made. The amount of oil fed into the retorts is based upon the indications from the gas at the try cock, and more or less supplied to accord with the temperature. After the gas is condensed, washed, and purified, it is metered and reaches the gasholder. The compressors are driven by steam and especially constructed for the purpose intended. The gas is received by them from the gasholder, compressed, and forced into large storage cylinders ready for delivery to the cars.

The oil required for 1,000 cubic feet of gas made in these furnaces is from 13 to 16 gallons of crude petroleum or naphtha. Our men prefer to use Pennsylvania crude petroleum, and the amount of coal required in the furnace for producing this 1,000 cubic feet is about 100 pounds, of course depending upon the quality. For compressing the same amount, about 80 pounds of coal is required in the boiler for making steam.

Gas is carried on cars in receivers suspended underneath the framing of the floor. For cars with a total of 150 candles light, and not more than two nights' service away from the charging plant, one receiver, about 9 feet long and 20 inches diameter, containing under 150 pounds pressure, which is our standard, about 200 feet of gas is sufficient. For cars having a greater amount of light, and in service on trips which carry them away from the charging plant more than two nights, additional receivers are used. Frequently two or three, and sometimes a total of four, receivers are used on each car.

On each side of a car is arranged a valve for attaching a gas supply hose, and this valve is connected by pipes to the receivers. It requires from two to five minutes to supply a car, or if more than one car is to be supplied at once, five or six can be supplied in as many minutes, provided they are all connected by hose to the gas distributing pipe lines at the same time.

In order that the high pressure on the gas receivers may be reduced to the small one needed for the burners, and the latter be constantly maintained, a regulator is used. The Pintsch regulator will absolutely and automatically control all pressures from 1,500 pounds per square inch down to ¼ pound per square inch, and maintain a constant pressure of about 1·4 inch of water at its outlet, no matter whether 1 or 100 burners are lighted, or whether all are shut off. The regulator is placed underneath the car, near the outlet of the gas receivers, so that all gas under high pressure is kept outside of the car, and away from the ends, so that in case of accident they are not liable to be broken.

The principle upon which the regulator works is that of an equilibrium of forces. The high pressure from the receivers passes through a very small orifice at the inlet of the regulator, which orifice is closed more or less by a valve, held against it by a system of levers and links. The latter to connect with a leather diaphragm of 50 inches area, and a variation of from 1 to 500 pounds at the inlet cannot appreciably affect the outlet pressure. The leather of this regulator is especially prepared to withstand the destructive action of gas on such membranes, and experience has demonstrated the thoroughness of this treatment. Many thousands of them are already in use, and it has never failed except from abuse or the breaking of the cast iron case inclosing it.

From the outlet of the regulator the gas is carried along by a ½-inch pipe to some convenient place under the car, where a pipe leads it to the top of the roof. At some available point in the pipe leading up through the car is placed a main controlling cock, by which the flames of all the lamps can be regulated. The pipe passes along on top of the roof of the car, which branches off to each of the lamps or burners in the car. The gas supply to each lamp is also controlled by a cock.

The satisfactory illumination of a passenger car requires a sufficient amount of light so distributed as to give an even, brilliant light the entire length of the car. A lamp of high candle power is not used, and if used would not be satisfactory. A sufficient number of lamps should be placed in a car to enable reading with perfect ease at any part of it, and to do this properly it is necessary to have the lamps not more than a certain distance apart. If spaced too widely apart then the shadows at a point between the lamps are so great as to be inconvenient, and lamps of not extraordinary power are therefore more efficient in lighting.

If the attempt is made to light with lamps of very high candle power, then, in order that the proper amount of light may be had at the points of minimum lighting, other parts of the cars will be over-lighted and over-heated, and the amount of gas burned and consequent expense of lighting will not increase directly as the amount of over-lighting, but according to the rule of squares. It has, therefore, not been the aim of the Pintsch system to use lamps of very high candle power, those ranging from 40 to 60 having been found sufficient. In fact, those of 40 candle power have been found the most satisfactory in even illumination.

The Pintsch lamps consist of the main body of the lamp suspended from the roof of the car either by a center column or by outside suspending arms. From a body is suspended a transparent bowl, which, with a white reflector extending entirely across the top of the bowl, with the exception of an annular space which serves as the entrance to the chimney, forms a chamber in which the gas is burned in fishtail flames. From two to six burners are used in a lamp, depending upon the light required at the location of the lamp in the car.

The upper part of the lamp consists of a glass crown or dome. The lower end of the flue or chimney of the lamp consists of a mica chimney, the upper end of regenerative passages. The light which escapes up the flue is reflected out through the mica chimney and the glass crown of the lamp, producing a pleasing and effective illumination of the ceiling of the car. The products of combustion pass up through the flues of the regenerative portion of the chimney, and the air for combustion is taken in near the top of the lamp and the top of this flue, and passing down outside of the mica chimney and between the reflector and a deflecting diaphragm, is highly heated before entering into the combustion chamber of the lamp. The effect of this absolutely shadowless and draught-proof lamp in car lighting is most pleasing, and produces a most brilliant and efficient light.

The Pintsch system is already applied to over 36,000 railway carriages, and is rapidly being adopted by the railroad systems of America. Gas works for the supply of cars are now in operation or course of construction at Boston, Stonington, Conn., New York, Jersey City (4), Syracuse, Marion, O., Chicago, Cincinnati, St. Louis, Denver, Ogden, and Atlanta, and over 1,200 cars are lighted by this system in the United States.

* A paper read at the recent annual meeting of the American Gas Light Association, held at Savannah, Ga.

PETROLEUM IN SOUTH AFRICA.

To the Editor of the Scientific American:

Allow me through the columns of your invaluable journal to call the attention of American capitalists and oil miners to the possibility of South Africa becoming a rich petroleum-producing country, there being localities in the Transvaal which several American travelers and oil experts have positively stated to be rich in rock oil, and one property, at least, would have been taken up by two gentlemen from Pennsylvania but for the interference of a middleman, who would not bring the principal parties into communication with each other. But for this unfortunate muddling a good "strike" of oil would have been made before now.

As it is, oil mining is quite a new thing in South Africa, and no one understands anything about it. So it is next to impossible to raise the capital necessary for drilling operations. I feel quite certain that if a stock company could be formed on your side to send out a proper "rig," with two experienced drillers, it would do well, as land owners and lessees would gladly cooperate in any way desired.

All the tackle could be sent to Cape Town direct, *via* Boston, with which city there is regular communication. Engine and boiler could be bought here, and the derrick made on the spot, thus saving freight and transport.

The consumption of illuminating and lubricating oils in South Africa is very great and constantly increasing. In the event of oil being struck in the Transvaal, there can be no doubt the government would protect and assist the local industry in every way.

In conclusion, sir, let me say that this is a country of great surprises. The diamond fields, discovered in 1870, now produce over £4,000,000 worth of diamonds per annum, and our Wilwatersvandt main reef, first opened in 1888, produced over 43,000 ounces of gold for last month (August), and the output is ever increasing.

Both of these discoveries were ridiculed when made, but colossal fortunes have since been made out of them, and it may be that a *new* industry, that of oil mining, may yet be established in the Transvaal, quite worthy to rank with diamond and gold mining.

C. E. LEAVILLE.

Johannesburg, Transvaal, South Africa.

METHOD FOR RENDERING ANILINE COLORS SOLUBLE IN BENZENE, CARBON DISULPHIDE, ETC.

THE processes which have hitherto been employed for the purpose of rendering basic aniline colors soluble in benzene are based upon treatment of the color with resin soaps. Another method, which I have used for more than a year for certain blues intended for a special industrial purpose, permits of the use of oleic acid and similar substances, or of ordinary soap. Two ways of effecting the desired change are open: 1. To commence by isolating the free base of the color, and, after drying it, dissolve it in commercial oleic acid in the presence of alcohol, which is subsequently distilled off. The mass left behind is the oleate of the base, and is soluble in benzene. 2. To make use of a double decomposition, by heating the coloring matter with an aqueous solution of Marseilles soap. The acid of the coloring matter combines with the sodium of the soap, while the fatty acids of the latter unite with the base of the coloring matter. I have found the second of these methods to be the most convenient in practice. When the coloring matters to be treated are insoluble, or only slightly soluble, in water, it may be useful to grind them up with a little alcohol before mixing them with the soap solution. When the colors are soluble, as for example methylene blue, this precaution becomes unnecessary, but, in any case, it is well to thoroughly mix the color with water. The preparation of a methylene blue, soluble in benzene, may serve to show how the process is carried out. Four liters of distilled water, 32 grammes of white Marseilles soap, dried in the air, and 32 grammes of methylene blue are required. The soap is dissolved in part of the water, and the color is ground up with the rest of it in a mortar. The two are then mixed in the cold, and the mixture is heated to the boiling point for at least half an hour, in a water bath, a more or less abundant lather being formed on the surface of the liquid. The vessel is then removed from the water bath and allowed to cool. On the next day, the blue is found suspended in the liquid as an insoluble precipitate, and is filtered off through a piece of linen. The separation of the color is so complete that the liquid which passes through is only very slightly colored. The precipitate is allowed to dry in the air and can, if required, be fused into the water bath. Its fluidity may be increased by the addition of a small quantity of oleic acid, and it can then be more easily run off into any vessel. The yield in this particular case is about 48 grammes, the equivalent of the fatty acids which have combined with the coloring base being much greater than that of the mineral acid which they have replaced. Each coloring matter has its special peculiarities, and the treatment must accordingly be modified to suit each special case. It happens, for example, in the case of light blue, that

the color remains partially dissolved in the soap solution. In order to separate it, it is only requisite to add a little hydrochloric acid to the solution. The color thus thrown down is completely soluble in benzene. The separation by filtration or precipitation may be altogether avoided by evaporating the entire product to dryness in the water bath. The residue of sodium salts and the excess of soap do not prevent the coloring matter from dissolving in benzene, when the mass is extracted with the solvent. It is worthy of notice that the oleates formed by basic colors may be heated without danger of decomposition to 100°, either dry or in the presence of water, while their solutions in benzene cannot usually be heated to a temperature some degrees below the boiling point of the lather without decomposing. In the case of light blue, for example, the benzene solution is decolorized by heat, and only takes up a small part of the color on cooling. Hence it becomes necessary to make the solution in the cold, grinding up the oleate with the benzene in a mortar. Induline blue does not behave in this manner. Its solution may be heated without fear of decomposition, and the following simple experiment may be performed with it. When a little of the blue is placed in a test tube, together with some water, some soap and a little benzene, it will be observed that, on heating, the layer of benzene which floats at the top becomes colored blue, and may even attain a very deep shade. There is no doubt that, in these preparations, oleic acid can be replaced by other acids, either free or as alkaline soaps. I do not, however, think it necessary to dwell on this point. The action of soap on basic coloring matters, and the solubility of their oleates in this reagent, explain why many colors when fixed without mordants, as, for example, on wool, cannot withstand washing, especially in hot water.—*Le Moniteur de la Teinture; Jour. Fabrics.*

ALIMENTATION AS A THERAPEUTIC MEASURE.

By Dr. G. ARCHIE STOCKWELL, F.Z.S.*

THE medical man who contents himself with merely prescribing definite forms of medication, and does not at the same time provide for the diet and nourishment of the invalid, "neglects"—to quote the veteran Edward John Waring—"to avail himself of a most valuable auxiliary, and may be allowing the presence of an antagonist which, in all probability, will counteract all the benefits that might otherwise be reasonably expected to result from his prescriptions."

Never was a thought more pregnant with truth. Fortunately, however, in these later days the importance of dietetics is becoming more and more recognized, and their study, both in practice and theory, as accessories to the exhibition of drugs, has led to better results, not alone in the case of convalescents, but in the very onslaughts and heights of disease. Instances are no longer of such frequent occurrence wherein well directed medical therapeusis is frustrated by indulgence in articles of food and drink without the sanction—and oftentimes in direct opposition to the desires—of the medical attendant, yet there is still vast room for improvement. It behooves the practitioner, in the light afforded by modern researches, to be precise and explicit, and abjure generalizations, since diet not infrequently proves the most potent of all the agents that go to make up the *armamentarium therapeuticum*.

"Directly man begins to live, he begins to die," says the erudite Thomas Hawkes Tanner, which is a more physiological expression of "In the midst of life we are in death" of the rubric. Food is life, and the various and divers ways in which it may be utilized are legion. The very foundation of the *cuisine* was a recognition of the principle of economy in nourishment. The physiological relations between the alimentary canal and the organism at large are most intimate, and doubly manifested with the onslaught of disease. Appetite, too, and the sensations of hunger and thirst, far from being mere local manifestations, are the demands made by the economy as a whole through the central nervous system for a renewal of material of which it has been deprived, or that has disappeared in the form of waste. Thus life is but a succession of wastes and repairs, so much so that the older physiologists were wont to assert that with each cycle of seven years the physical organism is wholly renewed.

Repair must have its source from without. Hence the ingestion of food in response to the demands of appetite. Then follows digestion, a complex act whereby the aliment is comminuted and transformed into materials available for assimilation. Assimilation represents the processes whereby the nourishment is taken up by the absorbents and converted into sources of energy, viz., blood, bone, and nervous and muscular tissue. So exact is this adjustment between waste and repair, that a mere trifle, apparently, may disturb the equipoise, when such disarrangement is of necessity morbid. In other words, if the aliment be deficient in quantity or quality, the processes of digestion are interfered with and there is waste without corresponding repair, and a pathological condition supervenes known as "inanition." The organism as a whole is lowered in tone to enable it to compensate for, and adapt itself to, the circumstances of supply, and thus it easily becomes a prey to other and external morbid influences; or perhaps the latter may be coincident with, and a cause of, the former. Were it not for these waverings of the balance and disturbances of the normal equilibrium, as determined by individual acts and surroundings or latent through heredity, there would be no disease, and the debt man "owes to nature" could only be paid by acts of violence.

Inanition, considered in its broad and general sense, and its relations to morbidity, is itself decay, or slow death, none the less certain because it is insidious; it is gradual starvation, and attended by precisely the same phenomena as accrue to immediate and total withdrawal of all nourishment. All parts of the organism, however, are not equally affected. Those which can be utilized as nitrogen and carbon are first consumed in the endeavor of nature to compensate or restore. This capacity of the economy to sustain itself for considerable periods of time without the ingestion of nourishment, in spite of constant excretion with diminution of body weight, is well understood by physiologists. The fact is, the organism possesses within itself a fund which in perfect health is added to day by day, so that the reserve is always somewhat in excess of the demand; and this is a matter of no small consequence in conditions of disease. If each day's nourishment exactly balanced each day's force, existence would be most uneven, and the dangers of disturbance to the vital mechanism greatly enhanced; but, by a system of storage, a proportion is saved under favorable circumstances to make good the deficiencies that accrue to possible conditions of abnormality; or, to employ the words of the genial Fothergill, "There exists a species of capital—a physiological fund—into which man can pay, or draw from, according to his necessities." By means of this reserve force it is possible to sustain life even when the system is wholly deprived of food for a little less than a fortnight—ten days, perhaps—while with slight daily accessions of nourishment it may be be maintained for a much longer period. Thus in acute disease the reserve enables the system to tide over the period of excessive and abnormal waste, even though it leaves behind an organism enfeebled and reduced in bulk and weight. From this it will be seen that even convalescence is not without its dangers, and also that it is a matter of vital importance in the management of disease that the physician be able to estimate fairly and correctly the extent and amount of reserve that can be depended upon in each individual case.

As an invariable rule in inanition, or excess of waste over repair, the fat first disappears, almost completely; the blood diminishes about three-fourths; the digestive organs and muscular system each more than one-half; while the nervous system is least affected of all. Chossat, nearly half a century since, compiled a table as the result of original researches, showing the percentages of waste, as follows:*

LOSS PER 100 OF DIFFERENT PARTS OF THE BODY IN INANITION.

Parts that lose more than the mean ⅓.		Parts that lose less than the mean ⅓.	
Fat	0·933	Stomach	0·397
Blood	0·758	Pharynx, œsophagus	0·342
Spleen	0·714	Skin	0·333
Pancreas	0·641	Kidneys	0·319
Liver	0·520	Respiratory apparatus	0·222
Heart	0·448	Osseous system	0·167
Intestines	0·424	Eyes	0·100
Muscles of locomotion	0·423	Nervous system	0·019

The most prominent feature of disease, then, and one common to all, is inanition, and rapid diminution of the nitrogenous and carbonaceous elements. There is impoverished blood, owing to disturbance in the relations of the conditions of supply and demand, whereby the force and frequency of the heart's action is diminished, and when prolonged, atrophy of this organ, whence we have death from "heart failure;" at the same time the respiratory acts are interfered with and the exhalations of carbonic acid decreased gradually and progressively, contributing by a corresponding lack of oxygen to the fatal result. Thus the organism quickly loses its power of maintaining the uniform temperature so essential to well-being, febrile movement and general excitation are enhanced, and finally comes disturbance of the mental faculties, amounting perhaps to delirium.

Such are phenomena that attend in greater or less degree every malady, since any morbid state must be dependent upon disturbance between the normal relations of waste and repair. To restore this balance by removing the offending cause, and by aiding nature in her efforts at repair, is the province of the therapeutist. And here many medical men fail, simply because they are accustomed to regard the relations of health and disease as matters of general mathematical addition and subtraction, and not, as is the reality, of conservation and compensation. In this connection the question of nourishment demands, always, first consideration, being paramount even to medication.

The chief source of the blood supply being food, it follows that the careful selection and preparation of nutriment are among the most pressing necessities of daily life. To expect to maintain healthy blood by scanty or improper food is as futile as to hope that healthy nutrition of tissue can be maintained by an insufficient or morbid circulation. There is, for example, no better physiological axiom than that the production of muscular activity depends upon a free supply of pure arterial blood, this supply being needed to facilitate that incessant transformation which is the necessary condition of muscular action, as well as to replace waste. Of the various alimentary principles, not one taken singly is capable of maintaining the normal constitution of the blood—albumen, fibrin, gelatin, gluten, sugar, starch, animal or vegetable fat, etc., consumed separately, cannot support life save for a very limited period, and, moreover, it has repeatedly been proved that any attempt to sustain nutrition by one alone creates disgust, even though one be dying from starvation. The value of every diet table, and of every substance employed as food, then, does not depend upon the amount of any one alimentary principle it may contain, but upon its possession of several such blended in proper proportions, and the facilities it offers for palatable transformation.

Of the four organic elements which principally compose the body, nitrogen and carbon are those which demand to be supplied most freely, inasmuch as the phenomena of nutrition arise from the chemical interchange of these elements with the co-operating influences of oxygen and hydrogen and certain salts. The average male adult in good health, performing an average of daily labor, requires every twenty-four hours from 250 to 350 grains of nitrogen, 3,000 to 5,000 grains of carbon, and perhaps 400 grains of salts; or, if we speak of nitrogenous and carboniferous foods, it appears that three or four ounces of the former are needed to twelve to sixteen of the latter.

The nitrogenous substances are those that are capable of being converted into the albumen and fibrin of the blood, and subsequently assimilated by the tissues. They are in part heat-giving, though chiefly indispensable for the formation of muscular and neurotic material. The fatty aliments also are essential to nutrition, since they are both plastic (nitrogenous) and calorifacient. Thus, to conserve and keep up mechanical force, the latter must be supplied in due proportion, just as the albuminates or plastic constituents are supplied. The carbohydrates, to wit, starches, sugars, gums, are believed to be simply combustible or heat-giving, hence are not plastic. In addition to these three groups, it is essential that certain salts and a due proportion of water be provided, since phosphate of lime, chloride of sodium, potash, magnesia, iron, and other saline ingredients are demanded in the production of osseous, muscular, and nervous substances, and can reach their destination only in the form of solution, as the body, both in health and disease, is constantly parting with these substances. So the normal condition cannot be maintained except by their replacement from without. Fortunately, all are largely present in those substances employed to satisfy the cravings of appetite. There are also substances which may be considered as complemental rather than real foods, such as tea, coffee, alcohol, etc., since while they do not *per se* increase bone, blood, or tissue, tend to better utilization of true foods, to prevent waste, and to unlock the storehouse of reserves.

As already intimated, disease is at all times a form of inanition, the demands of waste exceeding those of supply, when the reserve force must be called upon, the limit of which is death. The appetite, therefore, becomes a matter of importance from the very beginning of the malady; it is the index, so to speak, of vitality, since, if nourishment can readily be partaken of, there is a guarantee of at least a partial offset to waste, and the outlook is favorable. On the contrary, if anorexia supervenes, the prospect darkens, as it is *prima facie* evidence the digestive functions are deficient, and no longer capable of converting available nourishment into force. Again, the organic operation involved in nutrition, and also in the retrograde change of decay, can only go on at normal rates so long as a standard limit of temperature is maintained; the proper progress of the action of life implies a corresponding adjustment of heat, irrespective of the bulk of the individual.

Increased temperature tells of disproportionate combustion of carbon, and, consequently, increased and abnormal waste. This is the febrile state, and in which nature endeavors to compensate by distributing the "wear and tear" evenly throughout the economy. To supply the place of the fuel consumed by abnormal combustion, the entire organism is laid under contribution, and there is corresponding lack of secretion, and consequently of function and vitality. Thus, anorexia is often the first evidence of an insidious onslaught of phthisis, the digestive organs being depleted to compensate for the waste incident to a diseased lung. The supply of blood that should stimulate the nutritive function and support in normal activity is withdrawn at the expense of the digestive fluids. The nerve endings, that before conveyed sensations in response to demand, are deprived of nourishment and obtunded—decrease in vitality—and languish in semi or total idleness, or by manifestations we are pleased to denominate pain clamor for a restoration of the lacking blood supply.

Here then, with anorexia, we see the philosophy which has led to the exhibition of remedies calculated to stimulate the digestive function to renewed activity. Here the complementary foods, tea, coffee, alcohol, may serve good purpose, in connection with bland aliments easy of assimilation that at the same time tax as little as possible the crippled resources of the digestive economy. Here, too, nourishment is a matter of paramount moment, as the perverse and ailing stomach and duodenum demand to be cajoled rather than driven, as one would undertake to do with a peevish and sick child. Sufficient blood of proper quality cannot be had so long as there is a deficiency, and here we are dealing with the very fountain source of supply; force cannot be developed except through the accustomed fuel that evolves energy, and it is poor economy to rob Peter to succor Paul, and, moreover, is a most dangerous procedure, and one the penalty of which is death.

If to force digestion then is dangerous, but one measure is available, and that to compensate artificially for that which may be lacking. In other words, nature must be copied, even while gently stimulated to renewed activity, and at the same time she must not be taxed beyond her available resources. It is the virtual "lifting of a lame dog over the stile."

It was attempts in this direction that led to the use of the so-called digestive ferments and predigested foods, whereby the stomach, duodenum, and accessories might be aided in their functions, and the lacteals and portals supplied with the desired nitrogen and carbon for conveyance to the circulation. These were first given by themselves that they might intercept the nourishment and insure its proper transformation during its passage through the *primæ viæ*, but latterly it has been found less taxing to also add to the food prior to its ingestion, and thereby save the stomach and intestines (already deficient in secretion) much of the labor that would otherwise be necessary. Thus the diet of the ill and convalescent must be prepared in consonance with the demands and abilities of each individual organism, the problem being the greatest supply of nourishment available to generate vital force, with the least possible expenditure of the reserves.

There has been, and still exists, in many quarters, strong prejudice against prepared and predigested foods, but advancing knowledge, including physiological research, and the increased art of the chemist, are surely but slowly breaking down the opposition, and the time is at hand when dietetic therapeutics must receive equal, if not greater, attention than medicinal therapeutics.

In closing, it may be well to say a word regarding nutritive enemata. It is a well recognized fact that there are occasions, as in tetanus, marasmus, etc., etc., when it is not only convenient, but necessary, to support the vital organism otherwise than through the mouth. Inter-muscular and inter-cellular injections have not proved satisfactory, and further, even if available, are apt to inculcate as much of evil as of good. Transfusion, also, besides entailing a surgical

* Member of New Sydenham Society, London.

* *Recherches Experimentales sur l'Inanition*, Paris, 1843, p. 28.

procedure, is not available for continued use, besides, is attended by many degrees of uncertainty. There remains, then, ingestion *per rectum*.

In rectal alimentation we are confronted by the fact this portion of the economy is limited in its power to absorb, serving chiefly as a means of disposal of effete products of digestion. That it does take up a portion of the products of digestion that may have escaped assimilation in the lesser bowel must be conceded. Such, however, have been prepared for assimilation, in that the starch has been converted into soluble dextrine and grape sugar, and the proteids into peptones. If foods, then, are ingested into the lower bowel, they must practically represent the same conditions as they would had they reached the same through the upper *primæ viæ*, through the ileo-cæcal valve. This valve practically bars their entrance to the region where digestion, as differentiated from mere absorption, takes place. If not predigested, they are not fit for absorption. Nutrient enemata, then, should consist of soluble carbohydrates, meat peptone—fats are useless—and alcohol, the latter being of prime importance in stimulating absorption.

886 Jefferson Ave., Detroit, Michigan.

SMALL ELECTRIC MOTOR FOR AMATEURS.

By GEORGE M. HOPKINS.

EVERY piece of electric work done by a student or amateur is of value, not only as an addition to his collection of apparatus, but as a means of acquiring a positive knowledge of electricity and of electrical apparatus. The annexed engraving shows a simple and easily constructed motor, which very fully illustrates the construction and operation of the Gramme motor, and is well adapted to various uses requiring only a small amount of power.

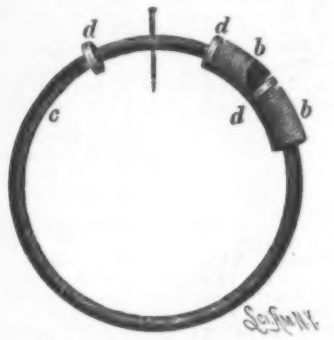


FIG. 4.—ARMATURE OF SMALL MOTOR IN PROCESS OF CONSTRUCTION.

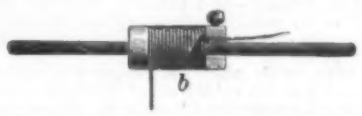


FIG. 5.—APPARATUS FOR WINDING ARMATURE COILS.

This motor was built by Mr. W. S. Bishop, of New Haven, Conn., after the general plans of the simple electric motor already illustrated and described some months since in these columns, but the construction here shown is more simple and more easily carried out. The perspective view here given is two-thirds the actual size. The front and side elevations and the smaller detail view are full size.

The field magnet, A, is formed of a yoke of Norway iron $\frac{5}{8}$ inch thick, $\frac{1}{2}$ inch wide and $2\frac{1}{4}$ inches long. In the yoke, near its ends and $1\frac{1}{8}$ inches apart, are drilled holes for receiving the quarter inch Norway iron cores of the magnet, which are driven into the yoke.

The polar extremities, *a*, of the field magnet are curved to form a circular opening $2\frac{1}{8}$ inches in diameter. The winding of the field magnet may be applied to the magnet cores, as shown in the engraving, or the wire may be wound upon spools fitted to the cores. The spools are 1 inch in diameter and $1\frac{1}{4}$ inch long between the heads. Upon each spool is wound 1 oz. of No. 24 double wound, cotton covered magnet wire. The yoke of the field magnet is fastened to the wooden base piece of the motor by screws passing upwardly through the base into threaded holes in the yoke.

The armature, B, consists of a small Gramme ring mounted upon a wooden disk secured to the armature shaft. The armature core, *c*, is a ring formed of a piece of annealed iron wire, No. 13 B. & S. gauge, having its ends beveled and drilled transversely to receive a pin, as shown in Fig. 4. A core of this kind, although theoretically not as efficient as a laminated core, answers every purpose in this very small motor, and greatly facilitates the construction of the armature. The core has an outside diameter of $1\frac{3}{4}$ inches. The outside diameter of the armature is 3 inches, and the inside diameter $1\frac{1}{4}$ inches. Upon the armature core are placed 12 coils, *b*, of silk covered, single wound magnet wire, No. 25 B. & S. gauge, separated by rings *d* of soft iron wire No. 13, the rings forming polar extensions which add to the efficiency of the motor. The armature coils are formed in a lathe on a mandrel, separately, as shown in Fig. 5. This mandrel consists of a piece of No. 11 wire having two collars $\frac{3}{8}$ of an inch apart, one of the collars being fixed and the other being removable. Each coil contains 4 feet 4 inches of wire wound in five layers.

To facilitate the removal of the coil from the mandrel, the first layer is wound loosely. After winding, and before removing the coil from the mandrel, the wire is cemented with paraffine or wax melted on the coil with a warm iron. After twelve coils have been completed, they are strung upon the armature core, *c*, in alternation with the iron wire rings, *d*, and when the core is filled, its ends are brought together and secured by means of the pin, as shown.

The wooden hub of the armature is now fitted to the ring, but before the ring is secured on the hub, twelve equidistant holes are drilled transversely through the hub, near its center, and in each hole is inserted a piece of No. 12 copper wire one-half an inch long. The ends of the pieces of copper wire are allowed to project one-sixteenth of an inch beyond the sides of the hub. The ring is placed on the hub, and the ends of the wire projecting from adjacent coils, *b*, are twisted together, and attached by means of solder to the copper wire pins extending through the hub and forming the commutator bars, the covering being removed from the extremities of the wire. It will thus be seen that to each commutator bar is connected the beginning of one coil

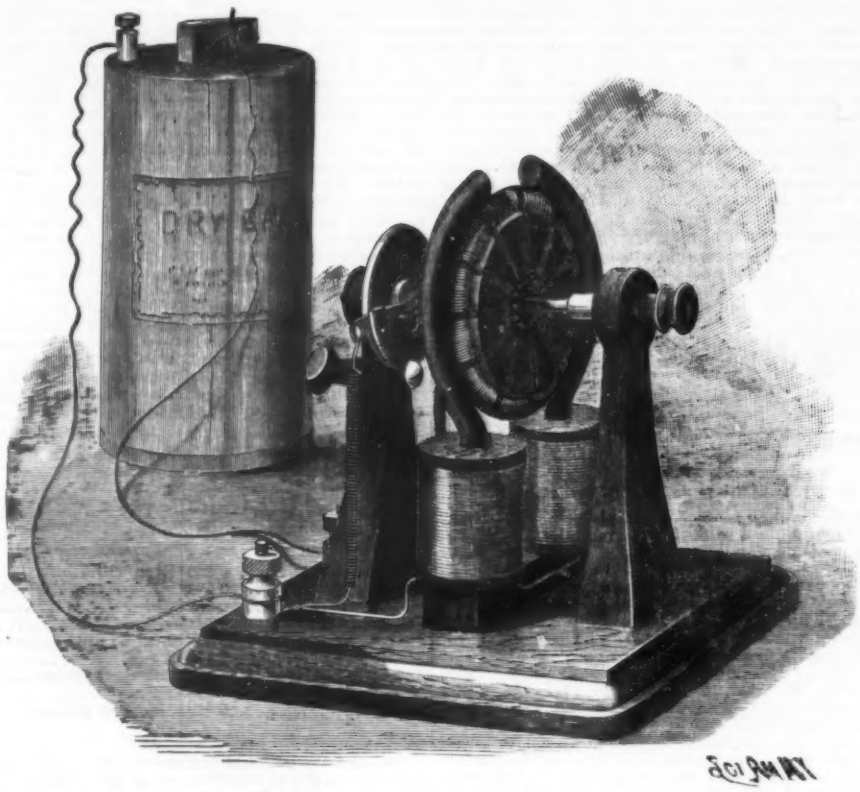


FIG. 1.—PERSPECTIVE VIEW OF A SMALL GRAMME RING MOTOR.

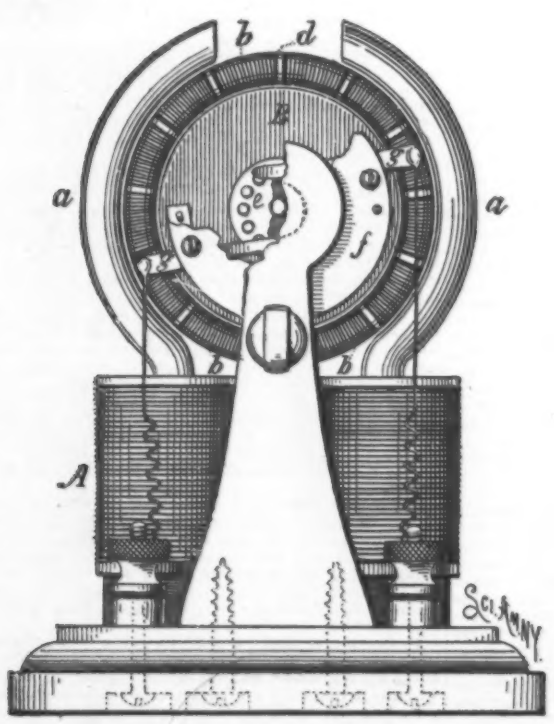


FIG. 2.—SECTIONAL SIDE ELEVATION OF A SMALL MOTOR—FULL SIZE.

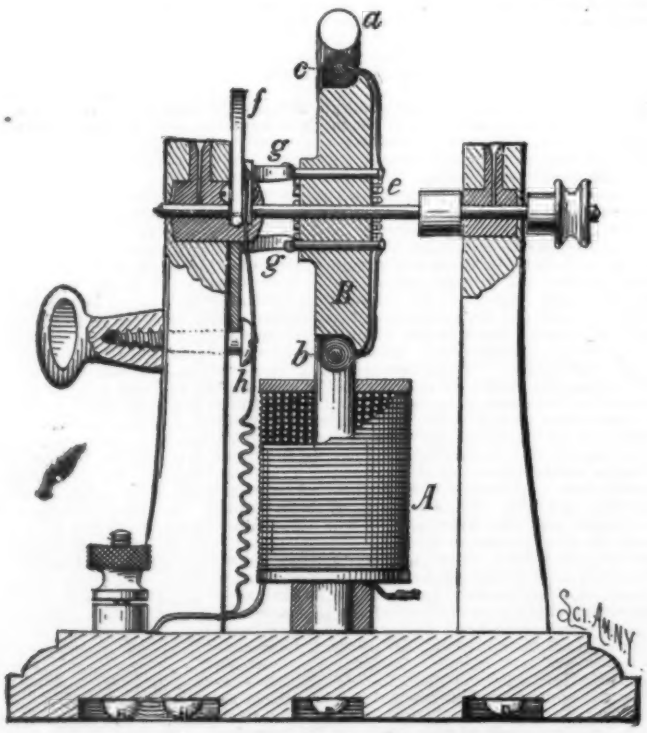


FIG. 3.—FRONT ELEVATION OF SMALL MOTOR—FULL SIZE.

and the end of the adjacent coil, so that by means of these connections the winding of the armature becomes continuous.

The posts in which the armature shaft is journaled are perforated near their upper ends with a hole of a size adapted to receive the armature shaft, and these holes are counterbored from the inner surfaces of the posts, and a wire of the same diameter as the shaft is placed in the position of the armature shaft, and Babbitt metal or type metal is poured into the openings around the shaft, forming the journal boxes. A hole is bored in the top of each post before casting the metal, to form an anchorage for the journal box, and after the casting, the anchorage is drilled through to the opening of the journal box to form an oil hole for the armature shaft.

The journal box on the side of the commutator is made to project beyond the inner face of the post to receive the disk, *f*, which carries the commutator springs, *g*. This projection is made by clamping to the post a piece of wood having in it a hole corresponding with that in the post. After the journal box is cast, the extra piece of wood is removed, leaving a sleeve upon which to place the disk, *f*. This disk is an inch and a half in diameter and $\frac{1}{16}$ of an inch thick.

To the inner face of the disk, *f*, are clamped the commutator springs, *g*, by means of small blocks, as shown in the perspective view, these blocks being held in place by screws passing through the disk into threaded holes in the blocks. The commutator springs are curved outwardly and their ends are turned backward toward the disk, *f*, and their extremities rest upon the commutator bars, as shown in Figs. 1 and 2.

The disk, *f*, and the clamping blocks are made of vulcanized fiber, which is strong and at the same time a good insulator. The commutator springs, *g*, are made of hard rolled copper, and their inner ends are adjusted so as to touch diametrically opposite commutator bars. The best adjustment for the commutator springs is found by moving the disk, *f*, in one direction or the other. It will be found that the maximum effect is secured when the contact surfaces of the commutator springs are nearly in a vertical line.

The disk, *f*, is clamped in any desired position by an ordinary wood screw, *h*, which passes loosely through the post and is screwed into a wooden thumb nut bearing against the outer surface of the post. The terminals of the field magnet, A, are connected directly with the binding post and also with the outer ends of the commutator springs, *g*, as shown in Figs. 1 and 3.

With one cell of dry battery the motor makes about 1,800 revolutions per minute, but it does not develop its maximum power until one or two cells are added in parallel. Any of the dry batteries will run it for short periods, but if it is required to run it continuously for any length of time, one or two cells of Bunsen or a Fuller battery should be used.

The motor being shunt wound, is practically self-regulating. Its speed with any amount of battery power does not much exceed 2,000 revolutions per minute.

[TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.]

ELECTRIC POWER TRANSMISSION IN MINING OPERATIONS.

By H. C. SPAULDING, Boston, Mass.

NEW YORK MEETING, SEPTEMBER, 1890.

THE rapid increase during the last few years in the number and magnitude of applications of electric power transmission to commercial uses in this country has been due principally to three causes: first, the ability and enterprise of those who have been identified with the progress of electrical industries since electric illumination became an economic fact instead of a laboratory experiment; secondly, the readiness of the American people to adopt new and advanced methods as soon as their superiority has been fairly demonstrated; and thirdly, the economy and flexibility of the apparatus employed, when properly designed and constructed, and installed under suitable conditions.

Basing our judgment on the world's advance in scientific developments during the past century, we may reasonably conclude that in no other country would the pioneers of electrical invention, whose names have now become household words, have received the prompt and plentiful financial support which has enabled them to inaugurate undertakings of exceptional magnitude, even in this era of tremendous monetary organizations. And, on the other hand, we have seen, in the numerous financial and engineering failures inseparable from such rapid development, the natural results of a too implicit faith in electrical omnipotence.

It is not to be wondered at that conservative engineers have been slow to adopt this new and mighty agent in the solution of extensive problems, and under circumstances where a single failure means not only a greater or less financial sacrifice, but the loss, in a greater or less degree, of professional reputation.

The mechanical engineer, while recognizing the fact that thousands of horse power are to-day transmitted by electrical means, from running the lathe in a dentist's office to the operation of a fifty ton traveling crane; from passing a cooling draught of air through a sick chamber to printing the plethoric sheets of our daily papers, hesitates, nevertheless, before placing reliance upon a system which has undeniably had its failures.

The mining engineer looks with interest upon the statement that 258* electric roads in the United States alone, with 1927·26 miles of track, and 3,024 cars, are in daily service or under construction, and then compares the demands of street service with those found in mining practice, looking meanwhile for practical suggestions from those who have "been there" and can hold up a warning or beckoning finger to the traveler in this unfrequented path. It is the object of this paper to present briefly some of the work already done toward the application of electrical apparatus to mining processes, as well as to embody some practical suggestions and statements from those who have had personal experience in the operation of such apparatus.

Following the natural order of operations, let us consider drilling and cutting machinery in the first place. The drill manufactured by the Diamond Prospecting Company, of Chicago, is designated by them as a Type "R" machine, nominal capacity 300 feet, and equipped with a motor of 3 horse power, rated capacity. The total weight of the machine, set up and running, is 1,000 pounds, and the heaviest piece, when taken apart for shipment, weighs about 170 pounds. The machine is mounted on trucks fitting the gauge of the mine tracks for easily handling, and can be taken apart in fifteen minutes, and put together in half an hour without difficulty.

The drill swivels so that holes can be put in at any angle, and can be operated in a space giving 5 ft. in the line of the drill rods.

The general arrangement of electrical and mechanical parts is sufficiently evident from the illustration, though the pump is hidden by the pedestal on the right. This is operated by the horizontal shaft driven by the bevel gearing shown, and supplies a constant stream of water to the diamonds through hose connected with the top of the drill tube. In a recent test on a granite bowlder, hole 1¼ inches in diameter, with slow speed, this drill cut 22 inches in 40 minutes. When set up in the mine and working on hard, compact limestone, it cut the rock at the rate of 1 inch per minute, not including stoppages for changing the rods.

For general prospecting purposes this drill seems to meet satisfactorily the requirements of its special line of work.

The general principle of construction of most electro-dynamic machinery provides us with a rotary motion, which it is necessary to transform to a reciprocating in order to obtain drills of the Rand or Ingersoll type. Any such transformation, however, entails a considerable loss of power, and we are happily relieved of this necessity by recent inventions which are based on the general characteristics of the solenoid.

The engraving shows such a drill, constructed under the patents of H. N. Marvin, of Syracuse. Mr. C. J. Van Depoele, of Lynn, Mass., was one of the first to appreciate the demand for this class of apparatus, as well as the possibilities of the principle involved; and a large factory is under course of construction by the Thomson-Houston Company, which will be especially devoted to drilling and pumping machinery of the reciprocating type.

MARVIN ELECTRIC DRILL.

A description of the general features of these drills will be found in the communication of Mr. Van Depoele.

Many machines have been placed upon the market, in recent years, for making the undercut in soft coal mining. Several of them have met with a certain degree of success in clean and easily worked veins, steam or compressed air (generally the latter) being the operating force. Perhaps the most successful of these machines has been that manufactured by the Jeffreys Mining Machine Company, of Columbus, Ohio; and a communication from Mr. Doe, their engineer, will be found appended.

Appreciating the advantages of electric power for this class of work, Mr. Jeffreys was not slow in adopting a motor, and has used a number of those manufactured by Foree Bain, the coal cutter being modified somewhat to utilize this power to the best advantage.

In the opinion of many practical coal miners, the principle of the rotating drill has many points of superiority in undercutting machines. Considerable experimenting and outlay in this direction has been made by the Hercules Mining Machine Company, of Pittsburg. A series of drills is operated by a Tesla alternating motor, the power being transmitted by a belt and the current being supplied to the motor by three armored cables. When in operation, the cutter is clamped upon rails parallel with the face of the coal, being shifted along this track after each cut, ready for another.

Compressible springs are wound upon each drill rod and serve as conveyers for the coal dust cut out by the drills.

A Thomson-Houston motor of a special type is used in this machine, current being supplied from the main entry wires (which may also be used for lighting, haulage, and pumping) by flexible wire-covered cables.

The series of cutters (nine in number, each 4 inches wide) is so arranged as to cut close to the wall beside which the machine is placed, and within ⅛ inch of the level of the floor.

Although the weight of the apparatus complete is less than 1,400 pounds, no clamping is needed, as the drills will "pull themselves into the coal," with only the friction of the machine behind them as it rests on the floor. The device for clearing the drills of coal dust is as simple as it is effective. It consists of a series of hinged scrapers hung from the under side of reciprocating bars, one of which is placed between every pair of drills, and which also operates an ingenious device for cutting out the triangular space left by the drills at top and bottom of the cut. The present type of machine makes a cut 3 feet wide, 5 feet deep, and 4 inches thick, in two minutes and a half, including withdrawal of the drills. With these figures in mind, the claim of 180 tons capacity per day for this machine does not seem excessive. As the extreme height of the apparatus is only 23½ inches, it can be used in a vein of any thickness, and two small drums are so placed in the rear of each machine as to enable it to draw itself on to a truck which accompanies each machine, ready for moving into another chamber. A simple but ingenious rotary drill is being constructed for operation in connection with this apparatus, deriving its power from it by a flexible shaft, and drilling the blast holes at the same time that the vein is being undercut.

Having thus briefly examined the present electrical apparatus for boring into ore or coal, so that it may be blasted out, let us see what means are at disposal for hauling it out of the mine, or from one point to another under the surface. Of course, in the majority of cases, the blast will be fired by the electric current, but a discussion of this application hardly comes within the scope of this paper.

To Mr. W. M. Schlesinger, of what was, at the period referred to, the Union Electric Co., is due the honor of constructing the first electric locomotive for strictly mining uses in the United States. This was of 35 horse power rated capacity, and was put in by the Lykens Valley Coal Co., Lykens Valley, Pa.

A series of iron rails were joined together to form a conductor for the current, which, after passing through the motor, completed its circuit to the generator by the track rails, which were connected also by copper wires.

A locomotive of 40 horse power capacity has been in operation at the Hillside Coal Company's Erie Colliery, near Scranton, Pa., and the machine is illustrated here as showing very fairly the conditions to be fulfilled by this class of apparatus in the anthracite coal regions of Eastern Pennsylvania.

The power plant consists of a standard Armington & Sims engine capable of developing 60 horse power, and a 50 horse power Thomson-Houston generator wound for a current of 220 volts potential, and the necessary appliances for its operation. The engine and dynamo room at the top of the shaft are in charge of the engineer and assistant, who operate the other mining machinery.

From the dynamo to the foot of the shaft the current is conducted by No. 0 Clark wires, inclosed in gas pipes to protect them from damage. From the bottom of the shaft the wires are carried overhead, about 12 inches outside of the low rail of each track, and are suspended from an insulator specially designed for this class of work.

Wherever turnouts occur, frogs are used, the conductors being soldered to them in the same manner as when used for street railway work. Connections from the mains to the overhead conductor are made at suitable intervals, and a portion of the current is utilized for lighting purposes, two 110 volt lamps being placed in series. There are fifty of these lamps—eight at the foot of the shaft, two in the pumping room, four in the blacksmith shop, and two in the slope room; the remainder being distributed along the gangway.

The rails are used as conductors for the return current, copper end connections effecting a complete metallic circuit. In adapting the tracks to the electric system it was found necessary to make a few changes to accommodate the increased output. The shaft sidings will accommodate seventy loaded cars and fifty empties, whereas, before, they had a capacity for but fifteen on each side. The track is 36-inch gauge. The other tracks are double gauge, or three-rail tracks, the gauges being 36 and 28 inches. They are made in this manner to accommodate the slope wagons, which are all of the narrower gauge.

The locomotive embodies many new features in motor construction and general design, and, under practical test, has shown that it is particularly adapted to the work required of it. It is built for a 3 foot gauge, and is of the following dimensions: Length over all, 9 feet 7 inches; width, 5 feet 3 inches; and height, 5 feet 6 inches. This last dimension can be considerably reduced by placing the rheostat at one end instead of on the top, as has been done in the present instance. The weight of the locomotive is 10,500 pounds, to which 1,800 pounds has been added to increase traction. The motor employed is of the type "G" railway motor of 40 horse power.

A novel trolley arm is used, which requires no attention when the motor is reversed. Its construction is such that a wide variation in the position of the conductor is permissible, a range of 3 feet 6 inches being easily covered, while the meeting of an obstruction simply causes the trolley arm to fall by the side of the car without resulting in any damage. From the trolley wheel the current passes along the arm to the fuse boxes, then through the rheostat and motor to the rail.

* August 1, 1890.

Pinions on the armature shaft mesh with intermediate gears, connection between these and slotted connecting rods being made through the ordinary crank pin and box. This arrangement allows for variation in position between the wheels and body of the locomotive which carries the motor; and, as the crank pins on the opposite sides are placed at an angle of 90 degrees, there are no dead points. The brake mechanism, rheostat and reversing switch may be operated from either end by hand wheels. The operator has everything under complete control, and can start or stop the car and reverse its direction, without moving from one position.

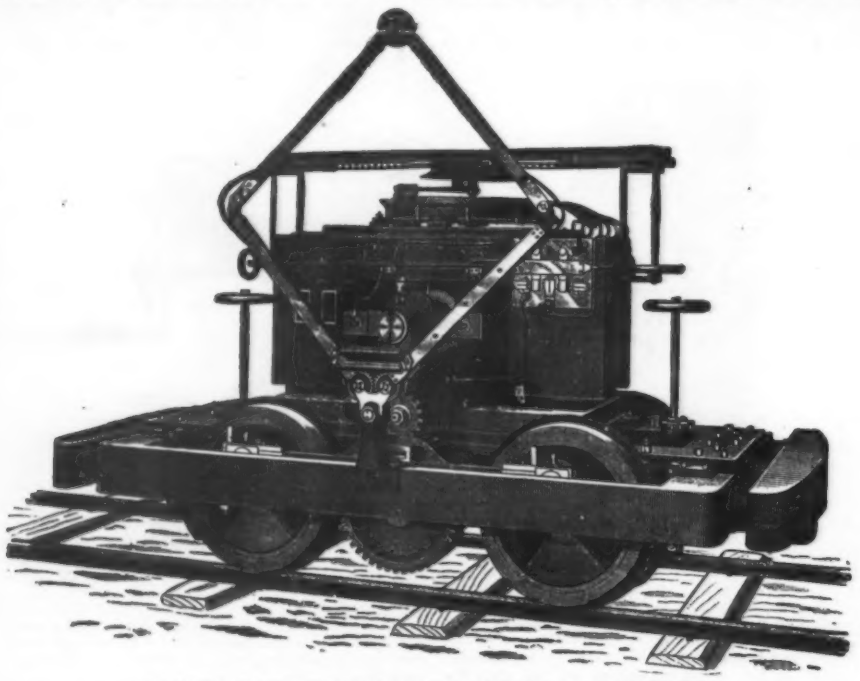
The locomotive is run by one man, who is assisted by a boy in making up trains and turning the switches. It displaces seven mules and three drivers. During a period of 11¼ days the average number of cars delivered at the shaft bottom by the locomotive was 559·5, against 526·95 per day delivered by mule haulage, much time being consumed by waiting at the bottom of the shaft for empty cars. Thus far, the locomotive has shown that it will increase the daily output to 700 cars per day.

To deliver 700 cars per day of 10 hours, the time of running the locomotive is 5 hours and 30 minutes, leaving 4 hours and 30 minutes for contingencies. The total distance run is 21·28 miles, and the locomotive is reversed 232 times.

The Thomson-Houston Company has now under construction for another Pennsylvania mine a locomotive of 60 horse power capacity, which (although of the same general type) will be so modified in design as to stand only 4 feet in the clear, above rails, the gauge being 3 feet.

The same general plan is applicable to mine tramways, of even 12 or 18 inches gauge, suitable for narrow entries, such as are found in some of the Western gold and silver mines.

For hoisting purposes, we may have a variety of



40 HORSE POWER ELECTRIC MINING LOCOMOTIVE.

forms and sizes, from a 3 horse whip, for hoisting small buckets, to a machine capable of operating a full sized cage under its maximum load.

In pumping machinery, a peculiar apathy seems to exist among prominent manufacturers as to the demands of this kind of work. There are, of course, innumerable cases where centrifugal and plunger pumps have been belted or geared to motors to accomplish certain objects; but the first pump of considerable size which, to the writer's knowledge, has been designed with special reference to operation by electric power, is in itself a mechanical unit, so to speak.

The pump is manufactured by the Gould Manufacturing Company, of Seneca Falls, N. Y. The tests made, with a view to determining the general fitness of the type for deep mining pressures, have been considered sufficiently satisfactory to warrant the designing of a standard line of pumps of from 50 to 500 gallons per minute capacity.

The pump consists of three vertical cylinders, within which are three single acting plungers, their cranks being hung from the main shaft at 120° angles, in order to produce the most even application of power. In addition to this class of pumps for general hydraulic work, the Van Depoele type of reciprocating engine is being adapted to a sinking pump which has, as yet, not been sufficiently tested to warrant further mention here.

I need hardly mention the subject of ventilating apparatus, as the application of motors to revolving fans of any kind is a mere question of belts or gears, though the fact that the fan, with its motor, may be located at any desired point within the mine, with an expenditure of power hardly greater than would be necessary outside, has a marked bearing upon the general arrangement and efficiency of ventilating systems.

The question of lighting, also, though a most interesting one to the engineer and operator, hardly falls within the scope of this paper. It is sufficient to call attention to the fact that the same wires which furnish current for a part or all of the apparatus enumerated above will make the interior of the mines light as day, and give a beneficial result, not only directly in the amount of product, but indirectly in the satisfaction and comfort of the men. This is not theory, but has been demonstrated to the satisfaction of all concerned, and in cases where there was, at the start, among the miners themselves, a hearty and bitter opposition to the new system.

Before considering the question of surface arrangements, let us pause a moment, to answer the oft-repeated question as to danger.

The danger of accident from any class of electric machinery in mining operations is of three kinds: First, physical injury from contact with conductors or apparatus, through which a current is passing; second, danger of fire or explosion from a spark in some part of the electrical apparatus; and, third, failure of the apparatus to work properly at critical moments. Regarding the first point, it may be said that a limit of 250 volts has been fixed by many experts in mining and electrical engineering for all apparatus to be used below the surface; and that *permanent injury* from a current of this tension, *regardless of its amount*, is *absolutely impossible*, the only liability to danger lying in secondary and indirect accidents, owing to the surprise and momentary discomfort due to an accidental shock. A hot steam pipe carries more danger for the man who unexpectedly touches it than a bare copper wire carrying enough current to cut and haul two thousand tons of coal a day, at the voltage named above. As to the second source of danger, no electrical apparatus, if properly installed, should ever spark, at known and properly guarded points; the amount of protection at these points being entirely dependent upon the knowledge of the designer, faithfulness of the operator and common sense of the purchaser, in spending sufficient money on safeguards. As to the third point, no class of apparatus ever designed is free from the possibility of accidental derangement, and at critical moments. But of electrical apparatus it may be said that no type of machinery will answer more quickly to sudden demands upon its capacity, or give a plainer indication of continued abuse; while, on the other hand, no system of power transmission is capable of more rapid repair in case of temporary derangement. We have but to compare the work of mending a broken air or steam pipe, or splicing a parted cable, with that of making a simple twist in a broken wire; and we need not wonder at the recent propheecy of a prominent naval officer, that coming war ships would carry no steam outside their boiler and engine room *

Let us consider now the demands of the generating system which will enable us to furnish the proper current to our apparatus to the greatest advantage.

If we have an abundant and steady water power at hand, so much the better, as the expense of maintenance then becomes practically a matter of interest on investment. If, on the other hand, we must rely on steam, let us be sure and have an ample boiler capacity to begin with. Many an electric installation has been condemned by casual observers when the fault lay between the coal pile and the dynamo belt.

Cheap machines will not answer for mining work. One cannot shut down for a few hours whenever it is desirable to have a new commutator put on, or a little shellac and braid here and there; and a thousand dollars more on the original investment is a good deal better than six or seven hundred a year for repairs.

A power plant just erected by the Pleasant Valley Coal Company, at Castle Gate, Utah, is in many respects a model of its kind.

It has a capacity of about 750 horse power of generating machinery, which will be used for furnishing current to electric coal cutters, drills, pumps, haulage engines, ventilating fans, etc., the entire power needed for the various mining operations being transmitted electrically.

As this is the first plant of such magnitude employing electric apparatus to the exclusion of other systems, the result will be watched with interest.

I append some communications kindly furnished by gentlemen who have given special attention to various branches of the subject of this paper. To these, as well as to others who have furnished various data of interest, I wish to express my thanks.

* Some of our latest additions to the navy have more than twenty steam engines for hoists, pumps, etc., in different locations, any one of which might be rendered useless by a stray shot, not to mention the demoralizing effect of escaping steam, while the wires of an electric apparatus for the same purposes may be almost instantly repaired.

THE ELECTRIC-MAGNETIC RECIPROCATING ENGINE.

BY CHARLES J. VAN DEPOELE.

One of the recent developments in the electric line is the perfection of a new electric-magnetic reciprocating engine.

For years past, and, indeed, ever since electricity was first used to magnetize an iron bar by means of a coil of wire, the idea of producing a reciprocating motion by the electric current has been entertained, and many unsuccessful attempts have been made to construct and operate such machines.

It is a well known fact that when a current is made to flow through a coil of copper wire, or what may be termed a solenoid, a bar of iron placed near the ends of such a coil will be sucked into the solenoid, and the moment the current is broken the plunger or iron bar will be dropped by its own weight, or may be expelled by means of springs if the machine is in any other position than vertical. This principle, however beautiful, could never be successfully applied in the construction of heavy machinery on account of the make and break of the circuit, which has to take place in order to produce the pulsations of the current which causes the pulling and letting go of the plunger.

Not until the invention and construction by the writer of an electric generator which would give currents rising and falling at a definite speed, could the current be sent to the coils of a reciprocating engine, there alternately attracting and repelling its plunger.

In this apparatus, however, as will be seen later on, the rising and falling of the current is produced in such a way that it is absolutely certain that no spark is produced either in the machine or in the generator producing the current. The current is caused to rise and fall in closed circuits, and actuates the plunger of the reciprocating engine with a speed corresponding absolutely to the speed of the defined rise and fall of currents produced by the generator. Thus, the generator can be caused to produce say 400 pulsations of current a minute, or it can be made to produce either a higher or lower number than this, so that the engine's speed can be regulated according to the size of its piston and the work it has to do.

The engine itself is a simple piece of machinery, consisting of two or more coils of copper wire, or solenoids, incased in an iron envelope protecting them from outside injury. Within these coils is placed a brass tube, and within this an iron plunger, capable of moving to and fro under the action of the currents in the coils. To the end of this iron plunger is attached a piston rod, similar to that of an ordinary engine, and to this is attached the hammer, drill, or whatever tool is to be operated by the engine.

A very simple means of connecting the reciprocating engine to the current is applied to the machine, so that it can be stopped and started instantly. The cables leading from the generating station to where the current is to be used are perfectly insulated in the usual manner, and switch boxes are disposed along the main cables.

From these, flexible cables are led to the reciprocating machine, so that it can be moved, if necessary, from one place to another, without any trouble whatever. The cable is incased in a rubber tube to protect it from injury and to prevent loss of current by contact with the ground.

It will readily be seen that one of the first applications of these machines will be to rock drills, such as are now in use in nearly all mining and rock work, for quarrying, prospecting, etc. The simplicity of the machine lends itself most readily to this application, as it will be seen that there are no movable parts on the whole machine, except the plunger and piston rod carrying the tool.

There are no valves, as in steam engines, no switches, no make and break of the circuit, and no exposed current-carrying parts, so that the whole can be handled with safety and without any skill above that of common laborers. By turning on the switch the machine is started, by turning off the current it is stopped. There is absolutely nothing to be done to the machine, except occasionally to pour in a few drops of oil, to lubricate the piston and its rod.

For ordinary mining work the drill is mounted on a tripod similar to that now in use with the steam and air drills which are well known to-day, or it can be attached to horizontal bars or to vertical columns. In fact, it lends itself to absolutely the same work as has been done heretofore by the air and steam drills. It will work in any position, from horizontal to vertical. The weight of these drills will be approximately the same as that of the steam or air drills of the same capacity, and everything is so arranged that the men accustomed to work the latter machines will find no difficulty in operating the new electric drills.

The apparatus for generating currents to operate these drills or electro-magnetic engines can be placed at any distance from where the drills are at work, and any number of drills can be worked from the same source, each drill working independently of the other, and whether one or more are in operation, the generator will regulate and furnish a current exactly proportional to the demand.

Where a long distance exists between the generator and the place where the current is to be distributed, a system of conversion is used, that is, the current is changed from a high to a low potential, so that the primary current, transmitting the power from the prime motor, can be of a high tension. Since this current could be guarded against possible contact, there would be no danger in using high voltage. At the point of application, the high potential is converted to a low potential of such pressure only as may be found desirable and practicable. Where the distance is, say, only one or two miles, it will not be necessary to use any system of conversion whatever, as a current of suitable potential can be run directly from the generator to the mines.

The main advantage, however, is the superior economy over the motors now in use where steam or air is to be conveyed to a distance of only a few hundred feet.

There is an enormous loss in this transmission, and methods of steam or air transmission are certainly very limited in scope. There is, also, the trouble of leakage, making a system of piping much more costly in main-

tenance. But this is done away with when electricity is employed. All parts are so simple, that they will require little or no repair for very long terms, and such repairs as will have to be made will always be much less expensive than in the case of steam or air driven machines.

THE PRACTICAL APPLICATION OF ELECTRICITY TO COAL MINES.

BY J. S. DOE.

It is now only about fourteen months since the Jeffrey electrical coal mining machine made the first really practical test of electricity in the mining of coal on record in this country. This was carried out in April, 1889, in the mines of the Shawnee and Iron Point Coal and Iron Company, at Shawnee, Perry County, Ohio, in what is known as the Big Vein coal field of Hocking Valley. This company had previously been experimenting upon electrical haulage, and, to this end, had put in a power plant consisting of a 40 horse power generator, built by Foree Bain, of Chicago, Ill., with an exciter, both being belted direct to a Beck high speed engine of 60 horse power. The terminal potential of the generator is 260 volts, and that required by the mining machine motors is 220 volts; therefore there is a loss of 40 volts in the line. In the course of the experiments at the Shawnee mines, the Jeffrey Manufacturing Company, which had been manufacturing for the past ten years a coal mining machine run by compressed air, was called upon to assist the coal company in the installation of its plant, and, in connection with that work, made and put in for trial the first electrical mining machine. The same machine, with only a few minor changes, has been in practical daily operation in the mines ever since; and during the same period the Jeffrey Manufacturing Company has installed or contracted for 23 electrical mining machines as follows:

The Thurmond Coal Company, Thurmond, W. Va., four machines, with two 80 horse power generators, and two 85 horse power high speed engines.

The Sterling Mining Company, Cannelton, Pa., two machines, with one 80 horse power generator, and one 85 horse power engine.

The Monongah Coal and Coke Company, Camdenburg, W. Va., five machines with three generators and three engines. This company will add more machines as fast as territory is opened to permit their use.

The Consumers' Coal Mining Company, Spilman, W. Va., two machines, one 60 horse power generator, and one engine.

The Ellsworth and Morris Coal Company, Jobs, Ohio, four machines, with two generators, and one 150 horse power engine. This company has also given an order for another plant of four machines.

The Upson Coal Company, Shawnee, Ohio, is now putting in a plant to consist of two or more machines.

All the foregoing plants have sufficient additional power to run from one to four more machines when required. A number of other orders, calling for many machines, are under negotiation at this time, and several of the above companies have contracted for additional machines, after a practical trial of their first ones, thereby testifying to their satisfaction with the use of electricity in coal mining. The distance from the power house to the working places in the mines varies in the above instances from 1,000 to upward of 5,000 feet.

As already observed, the motors on the mining machines are wound for 220 volts, with a capacity of 15 horse power. This voltage has been found to be perfectly safe, there being no danger from any accidental contact with the wire. The amount of work done by each machine averages from 600 to 900 square feet of surface under-cut in ten hours. It requires two men to handle the machine. The machines cut into the coal or fire clay bottom, as may be desired, at the rate of about 1 to 1½ feet per minute; the standard machine undercutting 5 or 6 feet deep, 39 or 42 inches wide and 4 inches high. After the cut is made, the cutter bar is withdrawn by throwing a lever; the machine is then moved over the length of the cutter bar for another cut, and proceeds as before. Upon completion of the room, the machine is loaded upon a truck provided for the purpose, and moved into another room for more cutting, the first room being then drilled and the coal shot down for loading.

The same power, electricity, has been applied to the running of electrical drills, manufactured by the Jeffrey company. These drills penetrate the coal at the rate of two or more feet per minute. The mines are also, in some instances, lighted by incandescent electric lamps. Electricity is also applied to the running of pumps and fans in some of the above named coal mines, with perfectly satisfactory results. There can be no doubt that electricity in coal mines has become a permanent, practical success. We are, however, only in the infancy of its uses. There will be many and valuable improvements made as time progresses; but, with the light we have, it is evident that considerable advantages will accrue to those who first put in electrical coal mining machinery. The saving in the cost of mining coal by machinery, as compared with hand work, varies considerably in different localities and in different sized veins; but it may be roughly estimated to average about 20 to 25 per cent., with an additional saving of merchantable product, since machine-mined averages coarser than hand-mined coal.

A few words may be added on the use of electricity in the hauling of coal. It is unnecessary, at this late day, to call attention to electricity as a motive power in the transportation of heavy and quick-moving loads. Our many street railway lines give us daily and hourly demonstration of that. The Jeffrey Manufacturing Company is building and has in practical operation electric mine motor cars of 20 horse power capacity, each weighing 5 tons, the same type of motor, with the same voltage, being used as on the mining machines.

The frame of the motor car is made of cast iron, with heavy cast iron draw bars, and pilots to clear the track of any obstruction, such as coal, etc. The wheels, 20 inches in diameter, have steel tires with steel axles, power being transmitted from the motor to the axles through straight pinions and gears. The speed of the motor car is eight miles per hour. The electrical power is transmitted to the motor by means of a 4-wheeled trolley running on a double all-metal line, placed along the side of the entry, there being no rail or ground return. Sand boxes and electric head lights are placed upon the motor. The "motorneer" sits at one end, and handles and guides his iron horse, fed from nature's storehouse, with far more comfort and ease than can be had with the stubborn mule.

The Jeffrey motor car has hardly as yet demonstrated its maximum power. We cannot say how much coal it would haul on a level. It has hauled as high as 50 tons in one train, up and over a 4½ per cent. grade.

The Shawnee and Iron Point Coal and Iron Company have one of these cars, and the Thurmond Coal Company another, while the Upson Coal Company is putting in the plant for one.

Accumulators and Mining.—At the Washington meeting, in February, 1880, Mr. Pedro G. Salom read a paper on "Electrical Accumulators, or Storage Batteries."

In the following paper, it will be my object to investigate the question, as far as possible, from a purely mining point of view. That the use of accumulators in mines is not far off is almost certain; and it will be of interest to many of the members to see how far this reservoir of power will bear filling and drawing upon at the present time, and what the relative cost of the two electrical systems may be expected to be, not so much in first outlay as in the running expenses of the plant.

The first thing to be decided is the weight of these accumulators, and the easiest way to define this is the weight per horse power. Mr. Salom says it takes 25 pounds of battery to give 1 horse power hour, and that to give 100 horse power hours or 10 horse power for 10 hours, requires 5,500 pounds of battery, or 220 elements; but 25 pounds is the net weight and 32 pounds the real total upon which we must base our calculations, so that we have a total of 7,040 pounds as the weight of this battery. The next question is, How much room will this take upon a mine locomotive? A mine locomotive of 10 horse power should not be more than 9 feet long, and 2 feet of this will be taken up by the bumpers, leaving 7 feet in length for the battery. Then for a 3-foot track it should not be more than 5 feet wide. Allowing 1 inch all round a cell, it will be possible to set ninety-six of these on the floor space of the locomotive; but we must have fourteen more than this, which will make the width 68 inches. The height of this cell is 8 inches; and, allowing 2 inches space above it, and 1½ inches of plank, the top of the second tier will be 19½ inches high above the floor.

If the motor is to be placed below this floor (and there is no other place for it), then the bottom of the floor will be 2 6 inches from the track, and allowing the floor to be 3 inches thick, to stand the weight, the top of this car will be 4 feet 4½ inches above the track. Remembering that the height of the 40 horse power motor at Lykens Valley is only 4 feet high, and the one at Erie Colliery, also 40 horse power, is 4 feet 4 inches high, and that they are both narrower and of the same length as the proposed storage motor, and of four times the power, there is certainly one point established against the present use of accumulators.

TABLE OF WEIGHT, ETC., OF ELECTRIC MINE LOCOMOTIVES.

Location.	H. P. of Motor.	Weight of Locomotive Pounds.	Largest Load. Tons.	Speed. Miles. Per Hour.
Zankerode	4·5	3,000	13½	6
Paulus	5 to 6	4,200	....	6
Lykens	40	12,000	165	6·8
Lykens	40	12,000	150	5·8
Shawnee	....	4,500	21	5
Buckingham	....	7,000	60	8
Buckingham	....	4,000	30	8
Bear Run	60	18,000	150	6
Erie	40	13,500	107	6

Returning to the subject of weight, we calculate that to that of the accumulators, 7,040 pounds, must be added that of the motor, say 1,300 pounds, the wheels and axles, say 1,100 pounds, and the frame of the machine, say for strength alone, 1,400 pounds, giving the total weight of motor, etc., as 10,840 pounds.

From the above, it appears that the small German motors weigh about 700 pounds per horse power, and that the large American motors only weigh 300 pounds per horse power, whereas the accumulator motor would weigh at least 1,000 pounds per horse power. It is true that weight is necessary to traction, but it is also true that unnecessary weight will entail loss of power, and from the very limited information at hand it appears that 700 pounds per horse power is found to work satisfactorily with small motors, and that the weight per horse power decreases as the horse power increases. Consequently, for a 10 horse power motor, 1,000 pounds per horse power seems to be too high. There will be a waste of power in moving this weight, and if we wished to operate a 40 horse power locomotive with batteries, the number of cells would be 880, and their weight 28,160 pounds. They might be divided into two batteries and towed in a tender, but even then each would weigh 14,080 pounds, and this would absorb at least 500 pounds of the total pull of the motor, when running on the level, and considerably more where grades are to be overcome.

Dr. Lewis Bell has pointed out that, whereas a good roadbed is necessary for electrical traction by overhead wire, it is even more imperatively so when storage batteries are used. We have found in practice that a 25 pound per yard steel rail is too light for a locomotive of 13,000 pounds weight to be run upon; therefore, there is no saving to be looked for in this direction by the use of accumulators. On the contrary, when we begin to put in a roadbed heavy enough to stand the weight of a locomotive weighing, say, 23,000 pounds, there are many disadvantages that the colliery manager will be the first to see. Besides the first cost of the track, the keeping of this weight of track in good repair, in a mine where the floor is forever moving (as it is in many of our mines), would be a work of no slight expense in itself. It appears, therefore, that not much is to be expected from accumulators as a means of haulage.

However, this is one side of the question only. There is another side which should be considered, and that is the use of the accumulator motor in collecting the cars to a point where the heavy haulage motor can reach them. The prospect, as viewed from this point, is more encouraging. From what I have seen of the work, a motor of about 5 horse power would do the work of three or four mules, and the weight would be about 5,000 pounds, as follows:

	Pounds.
Accumulators (110 cells)	3,500
Motor	600
Wheels and frame	1,000
Total weight	5,100

This machine could be built low, so as to take up little height. It is only possible to make this form a commercial success, in my opinion, when the gangways are low, and the roof would have to be cut to gain height enough for mules to work. Then, the cost of the cutting saved by the use of the motor would counterbalance the repairs on the battery and the extra care and expense in laying and keeping the track in order. The cost of the system may be estimated as follows—assuming the first cost of the locomotive complete to be $2,300, and allowing that the mine can afford to charge these cells for $40 per horse power per year, the generator and engine being already installed and doing work during the daytime, and this sum representing fuel and interest on machinery. The attendance should not be more than $300 per year, as the pump man and night engineer can do the work:

ESTIMATE OF EXPENSE OF FIVE HORSE POWER ACCUMULATOR MOTOR.

Interest, at 6 per cent., on $2,300	$138.00
Repairs to battery	500.00
Repairs to motor, etc.	150 00
Cost of power, at $40 per horse power,	200.00
Attendance in charging at night	300.00
Engineer, at $2 per day, for 260 days	520.00
	$1,808.00

The cost of running three mules and drivers would be about as follows:

Interest and depreciation (26 per cent.), on $450	$117.00
Feed, shoeing, harness and attention, at $0.33 per day	366.00
Three drivers, for 260 days, at $2 per day	1,560.00
Total	$2,088.00
Less	1,808.00
Annual saving on 3 mules,	$280.00
Or, for 4 mules: total expense	$2,717.00
Less	1.808.00
Annual saving on 4 mules,	$909.00

Or, about 44 per cent. on the investment, under the circumstances assumed.

The rail and track being an important item in the economy of this method, I think that perhaps the cheapest, and at the same time the best, method would be to use from 20 to 25 pound steel rail, and, in laying the track, to place the ties first about 3 feet apart from center to center, and on these, and under each rail, to place a string-piece of wood 1½ by 3 inches, nailed to the ties, and spike the rails on the top, keeping the stringer joints and the rail joints from coinciding. The combination makes as solid track, and a very smooth-running one, and it has the advantage of not lifting easily into very uneven points; the ends of the rails do not jump as when only laid on the ties, and the track has not the spring to it which is so injurious.

The true place for accumulators at present is in lighting, and it looks as if they could be used to advantage in this connection. They are very heavy, it is true; but the lighting arrangement for eight hours' work would not be a large or very heavy affair, and could be taken to the working place on the first car, and brought out on the last, so that it would not have to be carried by hand at all. The advantage to the operator would be material, as the men can work better in good light than in poor, and the coal would come faster and cleaner from a well lighted place. The lighting of switches, turnouts, etc., could be easily accomplished in all parts of the mine, and the jar which would be detrimental to traction would not occur in this case. The charging could be done at night, and a clear steady light delivered during the working hours.

THE USE OF ELECTRIC POWER TRANSMISSION AT ASPEN, COLORADO.

BY C. E. DOOLITTLE.

At the request of Mr. Spalding, I give a brief statement in regard to the plant in use at this place by means of which water power is utilized for generating electric currents and the latter are applied to mine hoisting, etc.

This mining town had been lighted by electricity for three years, the power being obtained from several small water powers, when, owing to the limited quantity of water flowing in the mountain streams of this region in winter, it became necessary either to put in a steam plant or to use water under a much greater head. It was determined to adhere to water power; and the construction of a plant, to use water under a head of 900 feet, was begun eighteen months ago.

A dam was built on Hunter Creek, about three miles from town, at a point where a dam 12 feet in height creates a reservoir covering several acres of ground. It has been necessary, during a few of the coldest winter nights, to draw upon the supply of water in this reservoir, but the reservoir always refilled itself during the following day.

From the dam, the water is carried some two miles in a wooden flume, buried in the ground, to the head of the pipe line. The pipe line is 4,500 feet long, and has a fall of 876 feet, giving a pressure of 380 pounds per square inch at the water wheels. Lap-welded pipe, 14 inches in diameter and about ¼ inch in thickness, is used.

In the power house there are eight Pelton water wheels, each two feet in diameter, and each capable of developing 150 horse power. The water wheels run at the rate of 1,100 revolutions per minute, and each wheel is belted directly to one or more dynamos. This power has now been in use more than a year, and has proved absolutely reliable. The wheels at present fur-

nish power to operate three arc dynamos, sixty lights each; four incandescent dynamos, supplying 3,500 incandescent lamps, and two 500-volt power dynamos, one requiring about 60 horse power, the other about 120 horse power under full load. Those power generators furnish current to electric motors used principally for hoisting in mine inclines. For this purpose, motors of the street car type are used, so that the speed is under the control of the engineer. The motors are connected to ordinary mine hoists by spur gearing and paper friction wheels. These electric hoists are all under ground, at points where it would be both difficult and expensive to obtain power in any other way. The distance of the motors from the dynamos is, in most cases, about two miles. Some of the hoists have been running more than two years, and all have proved satisfactory and reliable. The expense for motor repairs has been very small. There are also motors in use for running blowers, rock crushers, etc. The motors range in size from 3 to 75 horse power.

An electric tramway for mine use is now in process of construction. The locomotive for this purpose consists of a street car motor, mounted on a truck, with the armature shaft at right angles to the car axles. This arrangement involves the use of a set of bevel gears. There should be a special motor for this purpose, so designed that the locomotive will not be too broad to run on the 18 inch gauge tracks when the armature shaft is placed parallel to the axles, thus allowing spur gearing to be used.

While the application of electric motors to hoisting has been a pronounced success, there are still two obstacles in the way of the general utilization of electricity for all mining purposes, viz., the lack of electric drills and electric pumps. As soon as an electric drill is produced that will do the work of an air drill, and an electric pump that will take the place of the present sinking pump, then the time for the general application of electricity for all mining purposes, to the exclusion of other power, will be at hand.

THE CHICAGO INTERNATIONAL EXHIBITION OF 1893.*

By JAMES DREDGE, Member of Council.

THE suggestion that a great International Exhibition should be held in the United States two years hence appears to date from the summer of 1889, when the rumor spread that Americans, incited by the brilliant results achieved in Paris, determined that a similar celebration, but one that should surpass in extent and grandeur the Centennial Exhibition of the French Republic, should be held on the other side of the Atlantic. The year 1892 was selected because it will be the four hundredth anniversary of the modern discovery of the New World, or rather of some of its detached outposts lying to the southeast of Florida. It was on August 3d, 1492, that Christopher Columbus sailed from Andalusia; on October 12th following he took possession, in the name of Spain, of the Bahama Isles, and two weeks later of Cuba. It was not, however, until nearly six years later, and in the course of his third voyage, that he discovered the American Continent; and in this discovery he had been anticipated by Sebastian Cabot, who had been sent out on an exploring expedition by Henry VII. of England, and who was the first to set foot on the American mainland; this was on June 24, 1497. The choice of dates was therefore at the option of the organizers of the new scheme, and probably for some reasons it would have been preferable to have delayed the celebration until 1897 or 1898; that, however, would have been to dismiss the undertaking to a rather remote and uncertain future, and it was decided therefore that it was the first discovery of Columbus which must be celebrated, and that 1892 should be the year during which the commemoration should be held.

What was only a vague rumor floating over the Champs de Mars last year speedily took serious shape, and it became evident that, on or about the date first spoken of, an international exhibition would be held in America. There can be no doubt that such a scheme is an eminently practical and useful one. Sixteen or seventeen years will have passed since the great Centennial Exhibition had been held in America; and this long period has been marked by a development of resources, a growth of population, an increase in industry and in riches to which history can offer no parallel. In the United States, the Philadelphia Exhibition of 1876 already belongs to ancient history; but it is regarded as an epoch from which is dated the commencement of much that was new and good in American taste and culture, notably as regards house architecture and art publications. The great flood of annual travel from America to Europe had not then set in, and to most of the visitors to Fairmount Park, where the exhibition was held, the contributions from foreign nations were a revelation. Since that time, of course, increased wealth and facilities for traveling have brought an ever-growing crowd of visitors to Europe; and the lessons first taught at Philadelphia have been extended year by year, until the adaptive character of the American has assimilated, more and more, European habits and refinements, and the gulf that separated our manners and customs from theirs is growing narrower day by day.

In the United States, decisive action usually follows with great promptness ideas which are favorably received. In October of last year it was determined definitely, and almost unanimously, that the Columbian Exhibition should be held, and with this determination came the burning question: To what city should be awarded the honor and the responsibility? The claims of New York, of course, stood paramount, partly because to New York was due the credit of the original proposition, but chiefly for the reason that New York is the metropolis of the United States, the most cosmopolitan city in the world, and the one best known to Englishmen. Situated on the sea, with a harbor that allows the largest ships to moor alongside her wharves, the facility her position offers to visitors, as well as to the goods sent by exhibitors, are unquestionably very great.

To the city of New York, indeed, it seemed as though no other town could successfully contest her fitness or her right to the exhibition of 1892; but American rival cities are enterprising and presumptuous, and several others advanced claims more or less reasonably and stoutly maintained. Washington and Philadelphia, St. Louis, Cincinnati and Chicago, all entered the lists. Only one serious opponent remained, however, to New York after the first encounter; Philadelphia, who had snatched the honors of the Centennial Exhibition of 1876, could not expect a repetition of the same good fortune, which would have stamped her as the exhibition city of the United States. Washington, beautiful and attractive as she is, is wholly given up to political instead of commercial enterprise, and made no serious effort to gain a privilege that was thrust upon her rather than sought. St. Louis was too remote, and Cincinnati not large enough for such a responsibility, so in a very short time it became evident that the selection lay between Chicago, a thousand miles inland, and New York.

Before matters had been settled thus far, the approval of the Senate and the President had constituted the Columbian Exhibition as an enterprise indorsed and assisted by government, so that from the beginning its official character was clearly defined. As much to the surprise as to the indignation of New York, the city of Chicago maintained its claim.

With characteristic enterprise its citizens had, before the fray commenced, organized a corporation with a large capital. Not that it was intended to degrade the scheme by making it a commercial speculation, but because it was recognized from the commencement that the greater part of the capital necessary for carrying out this enterprise successfully must be raised in the city. Immediately after this had been done, delegates were sent to Paris to confer with M. Berger and other directors of the French exhibition just closed, to obtain all such information as would be useful in carrying on the conflict about to commence, and to organize the exhibition afterward.

One of the delegates was Mr. E. T. Jeffrey, and the other Mr. O. Chanute, a well known American engineer. The report prepared by these gentlemen, during their visit to Europe, was very long and exhaustive, and it proved of considerable service in the struggle that afterward took place at Washington. Of this struggle it need only be said that it was protracted and severe; New York and Chicago were practically the only claimants in the field, and much oratory and cunning argument were put forth on both sides. Probably New York committed the dangerous error of underrating its opponent; and certainly it had the fatal misfortune of suffering from political internal feuds, which of itself was sufficient reason for its losing the contest. In the end Chicago came out signally victorious; and, on April 25th of the present year, an Act of Congress was approved, providing for the celebration of the "Four Hundredth Anniversary of the Discovery of America by Christopher Columbus, by holding an International Exhibition of Arts, Industries, Manufactures, and the products of the soil, mine, and sea, in the city of Chicago." This legislation, while it constituted the Columbian Exhibition a government undertaking, pledged the United States treasury to but little expenditure, although there is but slight reason to doubt that, should the necessity arise, patriotic feeling at Washington, combined with the senatorial pressure from the Western States, would assure a liberal amount of government aid.

To such an extent is the exhibition regarded as a government undertaking, that the Act of Congress above referred to provides that the general control shall be vested in a United States Commission composed of two commissioners from each State and Territory, and of eight special members; this body is recognized as the Columbian World's Fair Commission. As a matter of fact, this commission was appointed in duplicate, so that a reserve force should always be on hand to fill up vacancies. The chief functions of this commission were to decide upon the site available for the exhibition; to approve of the buildings and general arrangements; to make allotments of space, to classify exhibits; to determine the plan and scope of the undertaking; to appoint the juries and confirm awards; and to make all arrangements with foreign exhibitors. The actual carrying out of details, and, in fact, the responsibility of the undertaking, falls, however, upon the executive committee, which has been formed from the original organization of Chicago citizens, the Washington Commission being instructed to withhold their assent to any actual steps being taken until the corporation could show that it possessed a *bona fide* subscription of at least $5,000,000, of which 10 per cent. was paid up, and further guarantee of $5,000,000, making in all $10,000,000, to provide for the expenses of construction and management. So soon as formal notification to this effect has been given by the Commission to the President of the United States, he will make proclamation of the fact, and will communicate with the diplomatic representatives of foreign nations, and through them invite their respective Governments to take part officially in the exhibition. As regards the active participation of the Government as an exhibitor, it is provided that a sum of $500,000 should be devoted to the erection of a Government building, to be filled with Government exhibits, which would be collectively contributed from various executive departments; such as the Smithsonian Institution, the United States Fish Commission, and the National Museum; the control of this collection being vested in a special committee. Another Government exhibit will be the complete reproduction of a first-class life-saving station, of which there are many on the American coast. The President is also empowered under the Act to hold a grand naval review in New York Harbor in April, 1893, and in which the navies of foreign nations will be invited to participate. Besides the foregoing, the American Government makes itself responsible for various other sums, the total authorized outlay being $1,500,000.

The corporation, acting under the general control of the United States Commission, consists of a board of forty-five directors, all of them carefully selected with reference to their influence and standing. Of these the president is Mr. Lyman J. Gage, one of the leading bankers in Chicago, and the secretary is Mr. Benjamin Butterworth, who is well and favorably known in political circles at Washington. The director general, elected only a few weeks since, is Mr. George R. Davis. Out of the body of directors a number of committees were formed. The executive committee with thirteen members, and others dealing with finance, grounds and buildings, legislation, national and State exhibits, foreign exhibits, catalogues and printing, transportation, fine arts, mechanical and electrical appliances, and ways and means.

The President of the United States has not yet issued the invitations of participation to foreign countries,* because the financial conditions prescribed by the act of Congress have only been very recently complied with, but it is expected that they will be delivered within a few weeks. It is very confidently asserted that as regards money, the prospects of the exhibition are absolutely sound. About 6,500,000 dollars have been subscribed by the citizens of Chicago and the various railway companies interested in the undertaking. Of this amount 1,000,000 dollars has been actually paid, and the balance is available on call as the necessity arises. It is anticipated that further subscriptions of 1,500,000 dollars under this head will be received. In addition to the foregoing, the city of Chicago is about to issue bonds to a further extent of 5,000,000 dollars. This issue was decided on at a special session of the State legislature in July last.

According to law in the State of Illinois, it is illegal for any city or township to issue bonds for a larger amount than 5 per cent. of the assessed real estate valuation of the city. Now the actual debt of Chicago, though only 12,000,000 dollars (about 10 dollars per inhabitant) made it impossible for the municipal authorities to have raised any such sum as they required under the existing law. The vote of the electors, recorded on November 4 last, showed a unanimous approval of the action of legislature in passing a special measure. The people of Chicago alone have thus subscribed 11,500,000 dollars. It is proposed hereafter to issue further bonds to the extent of 5,000,000 dollars, secured by the receipts from visitors.

This measure has doubtless been suggested by the highly successful policy at the Paris Exhibition, which secured, in twenty-four hours, no less than 30,000,000 francs to the exhibition treasury; what constituted the great charm of this operation to the public was the fact that a lottery was attached to it; but this feature will be absent from the Chicago Exhibition bonds, since lotteries of all kinds are regarded with disfavor in the United States. So far as the first item of capital is concerned—the 6,500,000 dollars subscribed—it is recognized that the amount, if the undertaking turn out to be a financial failure, will be lost, while the 5,000,000 dollars of city bonds will be added to the municipal debt, and gradually extinguished during a term of years. It is too much to expect that the Exhibition will turn out to be so remarkable a success as to repay all the money thus advanced; still, it is hoped, and with reason, that, after the entry bondholders have been paid—with a fair amount of interest yet to be decided on—a balance will be left in the treasury. In such an event, the amount will be divided *pro rata* between the city and the various bondholders. The people of Chicago maintain that they are quite prepared to accept the loss of the whole sum, if needs be, being convinced that the glory which will be reflected on their city, and the indirect profits which the exhibition will bring, will, in the end, far more than repay them for the money lost. But the figures I have just mentioned do not by any means represent the whole of the resources which will be available for exhibition purposes. In the first place, the United States government stands committed for an expenditure of $1,500,000; and, as has been hinted above, the persuasions of Western senators may, in case of necessity, charm far larger figures from the treasury. There is no doubt that all, or nearly all, of the various States will appropriate large sums for their own exhibits, and, while these will not swell the capital of the Chicago corporation, they will contribute, in a very large degree, to the completeness of the exhibition and the beauty and variety of its buildings. The legislature of the State of California has taken the lead in this matter, by appropriating 1,000,000 dollars for its exhibition expenses; and in other States the sums to be contributed for the same purpose are now being discussed. The total expenses of the Paris Exhibition last year amounted in round figures to £3,000,000. As the Chicago corporation has already in sight a sum of nearly £3,500,000 sterling, it will be seen that, making full allowance for the greater cost of everything in the United States, the financial part of the undertaking is fairly provided for.

One cannot help wondering why a claim was not put forward—when the battle of the sites was being fought—for the village of Niagara; it is difficult to conceive a location possessing more natural advantages than the area around the great falls. It would have been neutral ground, over which no jealous rivalry would have been wasted, such as that which was so active between the large contending cities; the hearty co-operation of Canada would have been secured; the waterfalls and the rapids above and below would have proved an irresistible attraction to the whole world, compared to which the interest felt in the Eiffel Tower would have been as nothing; the Cataract Company for utilizing the water power could have been in operation in 1893, and could have furnished all the power required for driving the machinery in motion and for other purposes. Niagara is not remote from New York, and at the same time it lies at the door of Canada; it is on the direct route to the great West, and has abundant communication in all directions by rail, lake, and canal. The fact that the place itself is but a village, and that the adjacent city of Buffalo possesses only a limited accommodation for visitors, would have been difficulties easily overcome by the enterprising American speculator and hotel keeper. It is true that the powerful local interests which will give the Chicago Exhibition extraordinary scope and vitality would have been wanting; but, on the other hand, it is reasonable to suppose that such a scheme would have been supported by a unanimous national enthusiasm, and with the falls of Niagara as a leading attraction, would have commanded a universal interest abroad.

It being, however, definitely decided that the Columbian Exhibition of America is to be held in the city of Chicago, it will be both interesting and useful to form some opinion as to the actual advantages of the site, both from a national and international point of view. This question having been settled, it is quite unnecessary to consider whether New York, Washington, or any other city would have been preferable.

* A lecture delivered before the Society of Arts, London, Dec. 3, 1890.

* Since the above was spoken, the presidential proclamation has been issued.

So far as foreign exhibitors are concerned, it would appear at first sight as though the commercial metropolis of the United States, situated as it is on the Atlantic seaboard, would have offered far greater advantages than those possessed by a city a thousand miles inland. It must be remembered, however, that facilities for transport are not the only questions which arise in connection with advantages to be derived from taking part in a great exhibition. The main object of an exhibitor is to bring his exhibits under the notice of the greatest number of probable purchasers, and the people of Chicago claim that their city possesses this advantage in a higher degree than any other town in the United States. Whether this be true or not, it is beyond dispute that Chicago is the great distributing center of a vast selling and purchasing community, the strength and importance of which is increasing every year.

The capital of the State of Illinois, Chicago is practically the commercial metropolis of the adjoining States of Indiana, Kentucky, Iowa, Wisconsin, and Minnesota, all of them devoted chiefly to agricultural and pastoral industries, the products of which gravitate chiefly toward Chicago and St. Louis. The State of Illinois, which has an area of 56,650 square miles, a length of 385 miles and a width of 220 miles, is almost wholly prairie land, the greatest elevations not rising more than 900 feet above the level of Lake Michigan. About one fourth of its whole area is devoted to the growing of corn, and one sixteenth to the raising of wheat, while over four million acres are used as pasture land. Almost the whole State is a vast coal field, the area of the coal measures being computed to cover 30,000 square miles. There are about 14,000 miles of railroad in operation in this State, representing a capital expenditure of more than £320,000,000 sterling. The gross income earned by this expenditure last year was £12,630,000, the net earnings being 33·10 per cent. of the total.

Although figures are uninteresting and difficult to retain, it is worth while to put a few on record to illustrate the railway business in this one State of the Union during last year. The number of passengers carried was 23 755,000, and the average distance traveled was 26·25 miles by each passenger. The cost of carrying each passenger for one mile was 1·721 cents. The number of tons of freight carried was 44,931,095, and the average distance hauled was 98·43 miles, the cost of transport being 0·513 per cent. In this large total minerals take the leading place, the tonnage being about 14,500,000. About 10,000,000 tons represent the product of agriculture transported, 3,500,000 tons the weight of animals, 3,000,000 tons that of lumber, 4,500,000 the tonnage of manufactured articles, and nearly 4,000,000 tons the weight of general merchandise. Of course a considerable portion of this large business found its way to the stock-yards, grain elevators, and wharves of Chicago, which are, moreover, crowded by the ceaseless flow of waterborne freight brought over the great chain of lakes from the eastward, chiefly in the form of general merchandise, or cleared from the city port toward the same direction, in the shape of cereals, meat, and minerals.

The city of Chicago is situated on the southwestern shore of Lake Michigan, and it covers an area of 111,360 acres, or about 174 square miles. It must not be supposed that this vast extent inclosed within the city limits is yet densely inhabited, or even built over. Great tracts of virgin prairie land are included within the boundaries; the extensions of the main streets are laid out across them, but they are innocent as yet of any purpose except that of occasional grazing, or of buildings here and there put up in advance of their time, by enterprising speculators or by persons with a taste for isolated residences. It is urged against the citizens of Chicago by the inhabitants of less rapidly growing American towns, that in their zeal to own the largest city in the world they will not rest till they have fenced in the entire State of Illinois; but this stricture is hardly just, for if the growth of the population continues at its present rate, another ten years will see the greater part of the spaces now vacant closely built over. At one extremity of the city limits, and included within them, is the suburb of Pullman, once an independent town, the construction of which was commenced nine years ago, and which has to-day a population of 11,000, chiefly dependent on the Pullman Company, which manufactures railway rolling stock on a very large scale. Some idea of the rapid growth of Chicago may be gathered from the fact that ten years ago it was, in importance of population, the fourth city in the Union; to-day it occupies the second place, coming next to New York, with a population of 1,098,576, as compared with 503,185 in 1880; the number of inhabitants has thus more than doubled during the last ten years. This is a far larger increase than can be shown by any other city in the United States, the growth of the population of New York having been only 307,000 during the same period. The following list gives the population of eleven of the principal towns in America, as returned by the census of 1890 and that of 1880:

Name of City.	1890.	1880.
1. New York	1,513,501	1,206,209
2. Chicago	1,098,576	503,185
3. Philadelphia	1,044,894	847,170
4. Brooklyn	804,377	566,663
5. St. Louis	460,357	350,518
6. Boston	446,507	362,839
7. Baltimore	433,547	332,313
8. San Francisco	297,990	233,959
9. Cincinnati	296,309	255,139
10. Cleveland	261,546	160,146
11. Buffalo	254,457	155,134

A reference to the tabular summaries of the recent census at the periods above mentioned shows that this growth is a natural and healthy one, and has not been exaggerated for the sake of effect. The increase in population of the States included in the North Atlantic division since 1873 to the present time is 40 per cent.; that for the South Atlantic division has been 50 per cent.; that for the northern central division, which includes Illinois, and is by far the most populous section of the country, 80 per cent.; in the southern central division the increase has been 60 per cent., while in the western division, toward which a flood of population has spread, the increase has been 300 per cent.; the total figures, however, in this latter case are comparatively insignificant.

The trade and prosperity of the city of Chicago appear to have increased as rapidly as its population; in 1887 the total value of the commerce of the city was estimated at the enormous sum of £240,000,000 sterling, and since then three years of unusual prosperity must have largely swelled this amount.

The history of Chicago begins in 1811, when the site was occupied by military outposts in constant peril from hostile Indians; and until 1831, by which time life and property had become more secure, it possessed only a few inhabitants isolated from the rest of the world. In February, 1835, the place was incorporated as a town, and two years later it was raised to the dignity of a city, with a population of about 5,000. From that time to the present, the municipal area has been extended seven times; in 1847 and in 1853; then ten years later, and again in 1869, in 1887, in April and in July 1889. The last annexation of territory was on an heroic scale; previously the area was 44 square miles, but by a vote of the people recorded on June 29, 1889, the limits were at once extended to include 138·24 square miles additional land, and the great metropolis was by this act endowed with a sudden increase in the population of over 150,000 people.

At the present time the city extends north and south for a distance of 24 miles, while from east to west it has a width that varies from 4·5 to 10·5 miles. Probably so sudden and great an increase in a city is without a parallel; and the most curious feature of the consolidation is that it appears to have been effected without any serious opposition, although by the change six independent municipal corporations, with all their legislative and executive powers, were absorbed, and their separate dignities and responsibilities swept away. It is, of course, this system of annexation that has contributed largely to the phenomenal growth of the city; but the fact remains that such a growth would have been impossible if the increase in trade and industry had not been equally phenomenal, and this increase would have been unattainable but for the vast development of the adjoining States, the trade from which naturally gravitates to Chicago as the center.

Of the extent and future possibility of the States lying to the west of the Mississippi—and the development of which greatly affects trade of Chicago—we can form but a very limited idea. The area on the west of the great river is twice as large as that which lies on the east, and of this what is not mineral land is, for the most part, richly adapted for agricultural and pastoral pursuits. The proportions of the Western States are almost beyond one's grasp. Texas could hold the whole population of the United States, and not be more crowded than Germany. Dakota could do the same, and so could New Mexico. The State of Texas alone could produce nearly all the food crops required for the entire country. It could raise more than all the cotton crops, and pasture lands as large as the entire State of New York would still remain. It is estimated that the arable lands of the west cover at least 900,000 square miles. There are 260,000 square miles of timber country; and, in 1880, less than one-fourth of the pasture was occupied with more than 61,000,000 of live stock. It would seem as if the future destinies of the United States must be controlled from the west, the population of which, by natural increase and by immigration, is growing with so much rapidity; where energy appears unbounded, and the wealth of the soil, as of the riches hidden beneath its surface, is inexhaustible. A well-known American writer says: "The unrivaled resources of the west, together with the unequaled enterprise of her citizens, are a sure prophecy of superior wealth. Already have some of the young States outstripped their elder sisters of the east in individual wealth. . . . . The west is destined to surpass in agriculture, stock raising, mining, and eventually in manufacturing. . . Beyond a paradventure the west is to dominate the east. With more than twice the room and resources of the east, the west will have probably twice the population and wealth of the east, together with the superior power and influence which, under popular government, accompany them."*

These sentences, written some years ago, would seem to be already partially confirmed, and if the forecast be too sanguine and enthusiastic, the conviction is nevertheless forced upon the foreign visitor that if the head of the nation lies upon the Atlantic shore, the heart beats in the Middle States, and the sinews and muscles are in the West. Certain it is that some such process of western domination as that described in the lines above quoted is now in progress, and when the mighty struggle comes, as come it must, and that possibly in no very distant future, between protection and free trade, it is in the west that the anti-tariff banners will be unfurled.

To give an idea of the importance of Chicago as a great trading metropolis, it is necessary to have recourse again to figures. The city is the converging point for 30,000 miles of railroad, and it is claimed that 81,000 miles, or nearly half the total network of railways that cover the United States, affect her commerce more or less directly. She is the main center of the vast trade carried on upon the chain of inland seas which gives her a direct waterway to the Atlantic, and places her, if not on a level with, at least only second to, New York as an American port. To her stock yards are brought a daily average of 30,000 head of stock, and with the exception of what is required for consumption in the city, is exported in various forms.

Hogs and cattle, with their various products, grain, and ore, form the staple of trade in Chicago, but besides these there are a vast number of imported industries that give employment to about 150,000 workmen; the number of miscellaneous manufactories in the city is about 25,000. During the year 1889 there were received in the city elevators, or on the wharves, 183·5 million bushels of grain and its equivalent in flour; this represents more than one-twentieth of all the grain raised in the United States.

The estimated value of the live stock received at Chicago last year exceeded £40,000,000, and nearly 5,000,000 tons of coal were delivered in 1889, and 650,000 tons were shipped; most of this was brought from the coal fields of Illinois, Indiana, and Ohio.

* "Our Country," by the Rev. J. Strong.

The steel works at Chicago are sufficiently important to produce a greater tonnage of rails than any other steel center in the country; in this industry, as in so many others, the position of the city is extremely advantageous, ore being delivered to the works for a freight of only 60 cents per ton, and the rates for coal are also very moderate; the ores chiefly used average about 60 per cent. of iron. With such a large grain trade, storage accommodation on a corresponding scale is a necessity; all, or nearly all, that is brought to the city has to be deposited in the elevators for subsequent transshipment into vessels, railway wagons, or into carts for local requirements. There are altogether some thirty elevators of the first magnitude, the combined capacity of which is 30,000,000 bushels. The largest of these great stores contains 3,000,000 bushels, but the average capacity is less than half this amount.

While it is difficult to obtain figures as to the total tonnage of through freight that arrives at, or is despatched from, Chicago, it may be interesting to note that at least 3,000,000 tons represent the bulk of the traffic passed through the city from various places for consignment without breaking bulk, which is more than 6,000 tons per day.

The lake navigation is, however, the most interesting portion of the transport trade of Chicago, and on this subject very detailed statistics are compiled. The harbor, as well as the whole of Lake Michigan, is placed under the charge of the United States Engineer Department, and, for a number of years, works of more or less importance have been carried on to increase the facilities for shipping and to give relief to the overcrowded river. The outer harbor has an area of 450 acres, about 100 of which are reserved for the future construction of docks and wharves, by reclaiming the foreshore and filling up for a width of some thousand feet, parallel to the existing bank. Outside, the harbor is inclosed by easterly and westerly breakwaters, as well as by a northern pier, all of timber, but it is intended to replace these by stone and concrete. Since the works were commenced, $1,500,000 have been expended on them, and the outer harbor has been dredged to a depth of sixteen feet. The lake navigation is open from the end of April to the beginning of December, so that only seven months are available in the year, although a small number of coasting vessels feel their way along the shore of the lake in spite of the dangers from ice. In the year 1870 there were 12,739 vessels arrived and 12,433 cleared at the port of Chicago, the total tonnage being about 5,000,000. In 1889 the number of vessels entering the port was 10,804, and that leaving 10,984, while the respective tonnage was 5,102,790 and 5,165,041. Besides the increase in trade, which has doubled during the last twenty years, it will be noticed that the larger tonnage was carried in 2,000 less vessels than in 1870, showing an increase in the size of the ships used, which now rises as high as 3,000 tons. It is, of course, to be expected that the lake trade should increase at a very rapid rate, because the freight charges by steamer can always compete successfully with those by rail transit, and thus give to such systems as the Erie Railroad special advantages, because over the greater part of the distance—that between Chicago and Buffalo—goods are conveyed by water.

Chicago possesses but few attractions to the general European visitor; it is a city of perpetual noise and bustle, where the constant roar of traffic and the ever-crowded streets banish all idea of repose. The longest day appears too short for its appointed work, and the whole object of life seems concentrated in the desire to shorten it by wearing it out. The increasing manufactures and population threaten Chicago with the same pall of smoke that rendered Pittsburg a byword till within the last few years, and as it is not probable that natural gas will be found in the vicinity, the problem of smoke consumption is even now one of formidable proportions.

Chicago is laid out with main streets or avenues after the fashion of most American cities, with narrower streets crossing, generally at right angles, a geometrical arrangement that possesses many advantages. The rule has, of course, many exceptions, rendered necessary in some cases by the intrusion of the sluggish Chicago River and its branches. The streets and avenues are wide, and on a dead level; the principal ones are bordered by vast piles of buildings which are the glory of the citizens and the wonder of visitors. Although the town has an area of 174 square miles, the prices of land in the central portion rise to fabulous amounts, and rents are dearer than in London; for this reason, and with a desire to possess the highest buildings in the United States, the blocks are run up to twelve, thirteen, and even fifteen stories in height. In some of these staircases are regarded as superfluous, and in all of them elevators, sometimes as many as eight or ten, run up and down all day at express speed. Street railroads, of course, form the chief means of transit for passengers, and it is in Chicago that the cable system of tramways has found its fullest development; the high speed at which the cars are propelled by this means is counteracted to a considerable extent by the heavy wagon traffic that crowds the ill-paved streets. The concentration of business is naturally greatest upon the branches of the Chicago River and the 35 miles of wharves that constitute the accommodation of the port. The streets crossing the muddy stream and its branches are connected by swing bridges, the constant opening of which, for the passage of ships, causes a continual congestion of traffic. This is avoided in some instances by the construction of tunnels underneath the river. Seven terminal stations, that provide for twenty-one different railway companies, add to the busy aspect of the city, and the great network of competing lines that concentrate over the suburbs, crossing and recrossing each other on the level, give the visitor a high respect for the superior intelligence of the American engine driver, who, assisted with only a very crude signal system, contrives to handle an enormous train business with but few accidents and little loss of life.

Except for theaters and parks, Chicago may be said to have no means of amusement, for which, indeed there seems no leisure. Possible visitors to the Columbian Exhibition of the idle class may take this information as a hint that they perhaps had better stay away. Besides the vast business blocks of the city and the Auditorium buildings, which contain a giant hotel, the largest theater in the world, hundreds of offices, scores of shops, and a government signal station, the pride of

the inhabitants lies in their parks, and the suburban dwellings of the wealthy inhabitants, who must be very numerous, if a conclusion can be drawn from the number and appearance of these residences.

A struggle scarcely less severe than that at Washington followed the victory scored by Chicago, and took place within the city itself. This was the battle of the sites, in which all citizens, and many who were not interested at all, took part with that energy and vehemence so surprising to an Englishman. Railway companies and Park Commissioners, the Government Committee and the local executive, even the United States Engineer Corps, took active sides in the dispute, while the Chicago newspapers, with but little patriotism and less reason, added to the confusion by indiscriminate condemnation. Of course order was evolved out of all this chaos, but not until much valuable time was lost, and more or less mischief done. One of the most lively causes of dispute was the so-called dual site that involved the arrangement of the Exhibition in two localities about three miles apart. Without explanation, this proposal appeared an unpractical one, though in reality it was attended with many advantages, and was in the end very willingly adopted.

Another matter of discussion was as to which of the parks in Chicago should be selected for the construction of the main buildings. Many such parks were more or less well adapted for the purpose, and each site, as it was proposed, found a large, number of enthusiastic supporters and an equal number of determined opponents. A large space of land was offered for the purpose by a private owner, and an extensive site close to Lake Calumet was also suggested. Both these latter proposals were, however, soon abandoned, because, though the ground in each case stood within the city limits, they were too remote to be practicable. In the end, a decision was made in favor of Jackson Park, a large and partly reclaimed space of about 800 acres, situated on the lake front, and in the southern part of the city. But it was felt that the space thus given by the South Park Commissioners was insufficient for the purposes of the exhibition, and efforts were made to secure the smaller and very beautiful Washington Park, lying at some distance away. After many negotiations, a satisfactory arrangement was entered into between the park commissioners and the exhibition executive, by which both Washington and Jackson Parks were ceded, as well as a broad connecting strip known as the Midway Plaisaunce, which connects the two parks. By this arrangement, an area of some 1,200 acres was secured for exhibition purposes, an extent felt to be amply sufficient, if not embarrassingly large. At the same time that this arrangement was completed, the difficulties that had existed between the executive on the one hand and the Illinois Central Ry. Co. and the United States Engineers' Department were satisfactorily adjusted. These difficulties had their origin in the demand of the executive for the cession of a piece of ground on the lake front, situated in Lake Park, in a central part of the city, and an addition to this space, by a reclamation of a portion of the adjacent foreshore. The total amount thus obtained would equal about 80 acres, and was required by the executive for the erection of special buildings. It was this independent space, three miles from Jackson and Washington Parks, which constituted the much debated dual site. But the railway company threatened injunction on the ground of trespass, and the government harbor board forbade the filling up of any portion of the lake, which is national property, so that for a long time it appeared as if the projects of the executive concerning the dual site would have to be abandoned. In the end, however, amicable compromise overcame the various obstacles, and the executive became possessed of the land, and of the power to extend it into the lake, under very favorable conditions.

It forms an important part of the exhibition scheme to utilize this park-lake site for the construction of large and possibly of permanent buildings for the display of pictures, and probably for collective exhibits of scientific rather than of commercial interest. It is intended also to add to these as many attractions for the public as can be devised, and that this part of the exhibition at least shall be kept open at night, for the benefit of visitors staying in Chicago and who may not feel disposed in the evening to go so far as the main exhibition buildings. The common sense of this proposal will be apparent when it is remembered that Chicago, like all other American cities, is deficient in public amusement and attractions, and it is thought by the exhibition executive that it would be possible to create special attractions for the public in this small area, similar to those that were so successful in our series of exhibitions at South Kensington—the first condition of success being the creation of serious exhibits to serve as an excuse for attending out-of-door amusements.

Having secured the two large parks of Washington and Jackson, with the connecting strip, the next important question that presented itself was in which of these parks the main buildings should be erected. Washington Park presents the advantage of being beautifully laid out with great stretches of grass and large plantations of fine trees. Jackson Park has the attraction of being on the lake, so that the exhibition buildings could be grouped along the shore of the fresh water sea. This arrangement offers many advantages, such as effectiveness of position, facility of dealing with sanitary questions, a close association of the naval sections of the exhibition with the main scheme. On the other hand, it involves larger outlays in landscape gardening, and it is more than probable that during some period of the exhibition the lake storms may prove inconvenient. We believe that, after careful consideration, the lake site has been definitely adopted, and that Washington Park has been preserved for separate pavilions, flower shows, and the like.

One of the special features of Washington Park is the racecourse and grounds of a famous Chicago sporting club, and this, with its various accessories, is to be included as a part of the exhibition. The strip of broad, flat land connecting the two parks has also to be utilized, and its position suggests it as being admirably adapted for conversion into a street of States and Nations. By using it for this purpose, a magnificent perspective of fine buildings presenting many varieties of architecture would result, and the various states and foreign countries taking part in the exhibition could be provided with ample space for erecting their offices, special pavilions and buildings for entertainment, beside which the famous Rue de Caire would sink into insignificance. Much work for the landscape gardener remains to be done before the greater part of Jackson Park can be completed, but nature has already assisted greatly by forming a number of large lagoons connected with the lake, which can easily be converted into spacious pieces of ornamental water.

It is not too much to say that no such favorable site has ever been placed at the disposal of an exhibition executive, both as regards size and beauty. The great dimensions of the grounds will, in fact, not improbably be a source of embarassment to the management, especially at night, for it is determined that the exhibition shall be kept open to the public after dark. The efficient lighting of such large spaces presents almost insurmountable difficulties, one of which is the expense that would be involved, and it will probably be found necessary to follow the example set by Paris in dealing with a much more restricted area, and place only a part of the buildings and grounds at the disposal of evening visitors.

Another serious problem which will present itself for solution will be the provision of efficient means of transport within the grounds. This requirement will offer an admirable opportunity to exhibitors of every kind of portable and surface railways, and to every system of traction and motive power. The astonishing success which attended on the little Decauville railway at the Champ de Mars last year will no doubt be repeated on a much larger scale in 1893, where the necessity for transporting visitors will be much greater.

Objection has been raised that the selected site is too far from the center of the city. This criticism, however, has no weight. In the first place, the means of transport provided will be ample, and the existing lines of railway running past the south parks can be multiplied. It is in contemplation to construct a special railway for exhibition traffic. Cable car accommodation can be increased indefinitely, and to provide for the reception of the large number of visitors which the exhibition will attract, temporary hotel and other living accommodation will have to be provided near the park. Moreover, the road from the city to the exhibition grounds is a very pleasant one, running along the dead level of the lake shore through Michigan Avenue and the magnificent Drexel and Grand Boulevards. As regards the beauty of its approaches, the Chicago exhibition of 1893 will also be unrivaled.

Although it is impossible to forecast the nature and extent of foreign participation, a tolerably accurate idea of the most important features of the national exhibits is not difficult to obtain. In mining and metallurgy, in agriculture, in live stock, in agricultural machinery, and in labor saving appliances, it may be safely predicted that the Chicago exhibition will stand pre-eminent. Brewing plant will be a distinctive feature, and railway machinery of all kinds will be of the greatest possible interest. Educational appliances, the art of producing books, the industrial applications of electricity, and an almost infinite variety of special machinery for working wood and metals, will make this exhibition of exceptional interest.

The system of classification has not of course been decided on, though it has received very careful attention by the executive. Generally it is intended that a decimal system of arrangement should be adopted, in which the groups should be divided into ten divisions, and each division into ten classes. It is proposed that the arrangement of groups should be as follows: (1) Agriculture and allied industries; (2) mines and metallurgy; (3) marine and fishery; (4) manufactures and other elaborative industries. This group would include machinery of all classes, the applications of electricity, industrial chemistry, pottery, glass, metal-working, furs and leather, textile industries, paper manufacture, etc. Group 5 would be devoted to food and its accessories, including the production from raw materials, preparation and preservation. Group 6, "The house and its accessories, costume and personal equipment," embraces the arrangement, heating, lighting, ventilation, and water supply of cities; architecture, furniture, dress, jewelry, etc. Group 7 is devoted to the pictorial, plastic, and decorative arts; and Group 8 to social relations and public welfare. The last named group includes music and musical instruments, medicine and surgery, hospitals and charitable institutions; exhibits relating to property and commerce, labor federations, and the art of war. Group 9 is that of science, religion, and human achievement. In this group would be included scientific instruments of all classes, publications, all sorts of ecclesiastical exhibits, and that special branch of educational work of which we know but little in this country, but which is such an important addition to all American churches. Group 10 is devoted to monographic and collective exhibits, a group which the executive appear desirous of encouraging, and of granting to special industries the privilege of taking their exhibits from the groups to which they properly belong, and arranging them separately in different parts of the main buildings or in independent pavilions. There are many obvious reasons why this method of exhibiting should be encouraged, on account of the advantages it offers to manufacturers and to the public. Agricultural and cattle shows will be of frequent occurrence during the exhibition, and racing and trotting matches will be held constantly. The advantages attending the proximity of Lake Michigan will add greatly to the attractions of the exhibition, and enable regattas and other aquatic entertainments to be held, and for the same reason scarcely any limit need be set to the importance and variety of the naval exhibits, which it is said are to include a reproduction of the fleet of Columbus.

The object of this paper is only to give some idea of the nature and scope of the coming Exhibition at Chicago, and of the more interesting characteristics and importance of the city in which it is to be held; but it has been by no means the intention to urge the manufacturers of this country to assist in making it an International Exhibition. It would be, without doubt, freely admitted in the United States that it depends on the action of England whether the undertaking will have to be confined within national limits, or whether it will be aided largely by foreign co-operation. A month ago the universal feeling in Europe was one of resentment against a country that decided, as it seemed wantonly, to close its ports to foreign trade; at present it is one of amazement at the spectacle of a nation that has risen to denounce its lawmakers and to sweep them from the capitol. But the result of the political cyclone that has devastated the Republican Congress remains yet to be seen, and it must not be hastily assumed that a reaction in favor of free trade has set in; the most that can be expected is that the effort to exaggerate protection, and to benefit eastern manufacturers at the expense of western agriculturists, has been defeated, and that foreigners will continue to find American markets as heretofore. If this should prove to be the outcome of the recent elections, there can be no doubt that the value of these markets to this country will continue to increase rapidly from year to year with the growth in the population and the wealth of the Western States. If it be assumed—and such an assumption appears reasonable—that the voice of the United States has been raised in a successful protest against any increased protection, English manufacturers will be able to judge for themselves how far the expense and trouble of exhibiting will be a justifiable speculation, and, in coming to a conclusion on this point, they should bear in mind that the Exhibition will be held in the great purchasing center of that section of the continent where the sentiment in favor of reduced tariffs is the strongest. In this place it may be worth while to call attention to a curious though natural result of the McKinley Bill. In anticipation of this obnoxious measure becoming law, American buyers had been for months before purchasing in the European markets on an enormous scale, and at the present time vast stocks have been accumulated, bought under the old tariff. The natural result of this, combined with the social revolution that appears to be at present taking place, but the results of which can have little commercial consequences for many months to come, will increase the stagnation of American foreign trade, since existing stocks will be drawn upon to the utmost, and further purchases delayed as long as possible, in the hope that, before they are exhausted, reasonable counsels will prevail, and disturbed commercial relations readjusted. In such a fortunate event the clogged channels of European trade with America would be cleared, and the volume of foreign commerce westward would be vastly increased. Should this desirable result be achieved within the next eighteen months, it is probable that the Chicago exhibition will be an international one in a broad sense of the term. But if time bring about a different solution than now appears probable, even should the McKinley bill be sustained, with all its evil consequences at home and the paralysis of American foreign trade, there would still remain certain branches of English history and art that would distinctly be benefited by being represented at the Chicago exhibition. In the first place, it must not be forgotten that at these vast gatherings foreign buyers come in crowds, and should Europe abstain from participation, new and valuable business connections will be secured to America that English manufacturers might have obtained; or still worse, existing customers may, and probably will, be taken from us if we are not there to look after our proper interests. Even with prohibitory tariffs, there are certain branches of industry that will continue to command American purchasers. For instance, no amount of protective legislation will enable the United States to approach this country in many departments of art industry. In saying this it must not be forgotten that America has created her own school, but at present the products of that school do not compete. In stained glass, the art products of the loom, in ceramics, high-class furniture, fine table and decorated glass, and in many other arts, this country will continue to hold her own for years to come, and to be the source from which American demands will be supplied; that these demands will continue to increase is practically certain, considering the abundance of money in the United States and the increasing taste for articles of luxury, which is gratified with considerable liberality. In this connection, too, it may be well to remember that the number of Americans visiting Europe augments from year to year—during the season just closed, the total number that crossed the Atlantic was greater than that which flocked over last year to visit the Paris Exhibition—and that London is rapidly and surely becoming a greater favorite with Americans as a place to visit, and especially as a place in which to purchase, than Paris. The number of American visitors is estimated at from 80,000 to 100,000 annually, and each of them leaves behind him in Europe at least £50; so that some four or five millions sterling—a large proportion of which is spent in purchases—is added to the wealth of Europe every year. On this account, it is reasonable to suppose that English manufacturers who take the risk of exhibiting at Chicago will form lasting and valuable business connections with Americans who take advantage of their frequent visits to this country to make extensive purchases, which they are able to pass into the United States as personal effects, and therefore free from duty. It should be mentioned, that it is the intention of the exhibition executive to establish, as a part of the undertaking, a vast bazar, where articles which are shown as samples in the exhibition buildings can be purchased. Considerable benefit is likely to arise from this arrangement, for every one knows how the purchasing inclinations of visitors are checked by inability to procure and carry with them objects which may attract their fancy when visiting an exhibition. Before the time for closing has arrived, the desire for possession has passed, and many valuable, even though transient, customers are lost. It is thus evident that there exist some strong and sufficient reasons for manufacturers to exhibit even though they have to do so under the disadvantages of a heavy tariff.

But there are other classes of industrials to whom the benefits to be derived from exhibiting are not doubtful. For example, the inventors of machines or processes for which United States patents are held, and which it is desirous to sell, will certainly find the exhibition a convenient means of drawing the widest public attention to their inventions. English manufacturers, too, who have been forced, under the pres-

sure of prohibitive duties, to establish factories in the United States in order that they may maintain their trade, will obviously find it to their advantage to appear in the English as well as in the American section, in order to impress upon the mass of visitors, who may be also their customers, that the articles they produce in the American factories are identical with those made in their works at home. In like manner manufacturers who are hesitating about establishing such branch works in America will be able to form a clear idea of the advisability of such a step, by exhibiting the goods they would propose to manufacture, for the criticism and approval of visitors; the outlay and trouble would, of course, be considerable, but the public verdict they would secure would serve as an excellent guide to them for pursuing or abandoning their project. It would not be difficult to find other illustrations to strengthen the assertion that the Chicago Exhibition of 1893 may be used by many of our manufacturers for their distinct benefit. The industrial sections of an international exhibition are nothing more nor less than a costly form of advertisement, and, like every other class of advertising, the most important results that follow are indirect. But just as it is useless to advertise in any medium where the goods announced have no interest for the readers, so it is clear that the Chicago Exhibition will be of no service to many classes of manufacturers in this country. Exhibits of agricultural machinery, of mining plant, of railway machinery (except, perhaps, signaling apparatus), of labor saving devices, of educational exhibits, and many others, would be absolutely thrown away, unless with very rare exceptions, so far as any commercial benefit to the exhibitor is concerned.

As regards the Art Section of the Exhibition, two distinct questions would arise; the first having reference to an art collection worthy of this country, and consisting chiefly of pictures lent for the occasion. Such a course was followed at the Philadelphia exhibition of 1876 with very satisfactory results; it is obvious that this class of collective exhibit has no reference whatever to commerce, and can only be carried out at a very heavy cost, which may be justified by the desirability of maintaining the credit of British art abroad. The other class of art exhibits has a more commercial object; there are many painters of excellence in this country who find it difficult to obtain and keep so large a number of clients as they desire, and these would undoubtedly find new purchasers in America in spite of the heavy tariffs imposed on paintings. Such an exhibit certainly may not be a representative one, but it would doubtless have the advantage of bringing to many struggling artists in this country a rich and liberal *clientele*.

Whatever objections there might be to the creation of a British Section in the Chicago Exhibition, there cannot possibly be two opinions about the advantages which would accrue to visitors from this country. Comparatively few Englishmen have any idea of the wealth and resources of the United States; of the progress and culture of its people in remote regions; of the part which America is destined to take in the near future in the civilization and commerce of the world.

The Columbian Exhibition will indicate how far America has advanced in industry and invention; a visit to those sections of the United States of which Chicago is the metropolis will give an idea, such as cannot be conveyed by any amount of statistics, of the resources of the country and the rate at which they are being developed by an energetic people. Except in some few branches of industry, the manufactures of the United States have not come into contact with our own in foreign markets, the fostering influences of protection, and the ever-increasing demands of a vast and rapidly growing population, have kept manufacturers busy in supplying home wants. But the time will come—and if a reduction of tariff should be one of the results of the accession of the Democratic party to power, the time will come quickly—when American industry will be stimulated into fierce competition with our own abroad, and our manufacturers will have to enter upon a struggle for supremacy, the severity of which it is impossible to predict. For this reason, to say nothing of the interesting experiences that can be gained, every Englishman who can spare the time and money should look forward to visiting Chicago in 1893.

Such a visit should, however, be undertaken with the object of work and not of amusement; neither Chicago, and as a matter of fact no other American city, possesses any of the attractions that Paris offers, but what is lost in pleasure is compensated for by instruction. The recommendations given above apply therefore only to those who wish to gain valuable information by hard work. As to the cost of such a visit, it may be said generally that, apart from the expense of traveling, and if the executive committee succeed in completing their arrangements with the hotel keepers in Chicago, the expense will probably be less than that of a visit to the Paris Exhibition last year. Exhibitors, of course, would have to be prepared to face a larger expenditure; however favorable the arrangements may be for the transport of goods, the long distance that has to be overcome will be costly; labor, too, commands higher prices than in this country, so that on the whole the cost of exhibiting in Chicago will be greater than that in Paris. Should the government see fit to appoint a royal commission endowed with funds, it is evident that exhibitors will be relieved to a considerable extent, as no charge will be made for space by the exhibition authorities, who will, moreover, extend to foreign sections the greatest possible liberality as regards the supply of power, lighting, guardianship, local transport, etc.

Whether the Chicago exhibition of 1893 is to be in reality as well as in name a world's fair, or the commercial relations of the United States with Europe are such as of necessity to restrict its scope chiefly to the display of national industries and arts, it is evident that the undertaking will be full of the greatest interest to the thoughtful foreign visitor, and a profit to not a few British manufacturers.

DISCUSSION.

Sir H. Trueman Wood said there was not much which any one could add, in the way of information, to the paper, but the question which naturally arose was What part would this country take in the exhibition? He had had many inquiries as to whether it would be desirable for English manufacturers to exhibit; but that was a question which every one must decide for himself. As had been put very plainly by Mr. Dredge, there were large classes to whom it would evidently be a great advantage to extend their American connection, and there were other classes in whose case one could see little benefit to be derived. But there was a wider and more statesmanlike view than that of mere personal interest; it surely was to the advantage of every nation to be on friendly terms with all other nations. Nations were but aggregations of individuals, and the more those of one nation came in contact with those of another the more friendly they would be. In the case of the Paris Exhibition, political reasons rendered it very difficult for the English government to take any part, and the unofficial committee which took upon itself to do its best in the matter really deserved the gratitude of the nation for endeavoring to make up in some way for the want of official action. He knew that it was a great satisfaction to the French that England was represented in Paris, and in the same way it would be a source of gratification to America if England took a part, and especially if she took an official part in the Chicago exhibition. It was of course obvious that a very large number of Americans regarded England with the same feelings of affection with which we as a whole regarded our cousins on the other side of the Atlantic, but on the other hand there was a large party in America who did not share these friendly feelings, but felt, in fact, very bitter against this country. But the more we could enter into American projects, and help on any national movement they might take in hand, the more would the feeling of friendship be cultivated, and that of animosity overcome. If this exhibition became really international, he hoped this country would be represented officially. No one knew better than he did the difficulties which unofficial committees and commissions had to encounter. He should never forget the kindness which was shown the English Commission in Paris by Lord Lytton, but he could only do so individually as Lord Lytton, not as the English ambassador, and in that way alone the commission lost a good deal of influence, and he could not help contrasting the hard work they had on many occasions with the ease and smoothness with with which things worked on a former occasion when the Prince of Wales was at the head of the commission, and Sir Philip Cunliffe-Owen was its active and energetic officer. He hoped that although there were many cases in which it might be worth the while of individuals or firms to exhibit, some way might be devised by which great centers of industry might be represented collectively. The Manchester Chamber of Commerce, for example, might find it worth while to take steps to insure that cotton manufacture was represented, although individual cotton spinners might not feel justified in incurring the expense; and so with Sheffield, Birmingham, and other manufacturing towns. He hoped they might look to the patriotism of the country to see that if the country was to go abroad she should be worthily represented, even if it did not pay directly and immediately. If England did not avail herself of this opportunity for an advertisement, other countries would not be slow to do so. If the cotton spinners of Manchester did not exhibit, those of Belgium, the north of France, and elsewhere, probably would, and then England would suffer in the estimation of the world. A commission need not be so costly an affair as some had been in days gone by. The Paris committee had shown that it was possible to run a section respectably with very little aid, and make it self-supporting. All that government need be asked for was the benefit of the national influence, protection, and support, and for a moderate subsidy, which might enable the country to be represented in those branches, such as education, science, and art, in which it could not possibly pay individuals or even groups to exhibit. Either individually or collectively, the commercial classes ought to be able to find the money for commercial exhibits, but the country might be called upon to defray the cost of those non-commercial exhibits from which no profit could be derived. He complimented Mr. Dredge on the admirable way in which he had brought together a vast amount of very valuable information, which he was quite sure would be very serviceable to large classes in this country. He had treated the matter very fairly and impartially, pointing out both the classes which would gain from taking part and those which would not.

Mr. J. S. Jeans said he had been recently both in Chicago and New York, and had heard a great deal about this Exhibition. In the latter place the people declared it would be a *fiasco*, while in the former they all declare it would be the finest Exhibition ever held. He believed the McKinley Bill, and the great uncertainty in connection with all tariff matters, would seriously imperil the success of the Exhibition as regards Europeans. He did not think the iron and steel industry would be represented to any large extent. They did not send to the United States any considerable quantity of iron or steel, except tin plates, and one of the main objects of the McKinley Bill was to exclude tin plates altogether from the American markets. There seemed to be a strong determination on the part of Americans to manufacture everything for themselves, and unless the impression were removed, he feared the assistance Mr. Dredge had bespoken for the forthcoming Exhibition would be largely withheld. Something would also have to be done to facilitate the Custom House arrangements, of which he had had some experience recently, and nothing could be more abominable than the way in which one was driven about from pillar to post in the effort to get articles through which were never intended to be sold or disposed of in any way. He spent nearly a whole week in this way, and only succeeded at last by bringing strong pressure to bear on the authorities, even after the duty had been paid. If that sort of thing went on, the Exhibition would be likely to do more harm than good. On the other hand, the Chicago people were the most enterprising on earth, and nothing struck him more than their extraordinary energy. The best evidence of that was the fact that in the year 1889 alone the number of houses built was exactly half the total number destroyed by the great fire. He was sure nothing would be wanting on their part to make the Exhibition a success.

Mr. C. M. Kennedy, C. B., remarked that the part which the Society of Arts had taken in former Exhibitions rendered this paper and the discussion particularly appropriate; but until a formal invitation had been given to foreign countries to take part, nothing definite could be said as to the course to be adopted. Whatever body superintended the organization of the British section would have to depute the practical work to a special commission or committee, and upon that committee no doubt gentlemen would be placed who had had experience in previous exhibitions, as well as manufacturers and exhibitors themselves If it should fall to the society to undertake in any way the organization of that commission, they might be quite sure from past experience that the national interests would be well safeguarded.

Mr. Kohlsaat said, though he came from Chicago, he was not present in any official way as representing either the city or Exhibition. He, of course, felt great interest in the matter, and was sure that before 1893 some of the difficulties which had been alluded to would be removed. If the last election meant anything, there were many articles which might be sent from England which would amply repay exhibitors, and whatever the outcome might be, if the government did not see fit to do anything, he wished to thank the Society for the kind attention they had given to the subject. The paper contained a great many statistics, especially referring to population, which had not been read, which he hoped would be read when it was published. Many people thought that all the population in America centered round New York; but it would be found that, while the population within 500 miles of that center was 17,000,000, within 500 miles of Chicago it numbered 22,000,000. That showed the great advantage to foreign exhibitors of bringing their goods right to the people. They would be taken all the way in bond, and would not have to be touched until they arrived at Chicago.

Sir Frederick Bramwell, Bart., F.R.S., said he had no particular knowledge of Chicago, not having been there since 1853, when it was a very different place to what it was now. It was his fortune to preside over the Inventions Exhibition, and he had found that duty so onerous that, ever since, he had rather avoided the subject; and notwithstanding the cordial invitation of Sir Henry Trueman Wood, who promised to look after him, he did not even visit the Paris Exhibition. This one at Chicago would no doubt be of an extremely interesting character, and if energy, determination, intelligence, and lavish expenditure of money would make a success, it would certainly be successful. The question whether it would be to the interest of English manufacturers to exhibit there they must decide for themselves, but he quite agreed with Sir Henry Wood that there was no reason whatever—as there was at Paris—why the English government should not recognize the Exhibition officially; it was very desirable, whatever might be done by private exhibitors, that the government, when invited, should give its official stamp to it. It would not only please the Americans, but it would afford a considerable stimulus to individual exhibitors, and lead to a larger representation than would otherwise take place.

The chairman said he agreed with what had been said as to the importance of official recognition. So far as the trade interests of the country were concerned, if they were to be represented at all in this exhibition, which would be far in advance of anything of the kind which had taken place in America before, we ought to be represented as a nation, and under the auspices of the government of the day

Undoubtedly we shall be in a better position in 1893 than ever before; there was a better organization among the various trades, trade literature was more developed, and there was every opportunity of appealing to the public spirit of really representative men in the various industries to come forward at the request of the government and do their best to see that Great Britain was properly represented. To a great extent we exhibited for the purpose of promoting our own interest; but independently of that, he trusted that there was still alive in England the desire to show other nations of the world that we were not behindhand, that we were not yet beaten by our children, and that we could hold our own at present as well as we could forty years ago, when, in 1851, we were, by common consent, admitted to be far in advance, except in certain special matters, of all other commercial nations. He could understand that, from a pecuniary point of view, there would be an unwillingness to support the exhibition, in consequence of the McKinley tariff; but, even assuming that no change was likely to take place—which was hardly probable—he hoped the feeling of annoyance would not be allowed too much weight. He did not look upon it at all as simply a question between England and America. Chicago would be largely visited by representatives of other nations less developed and less advanced than the Americans themselves, who would regard Chicago as the center of western civilization, and go there to widen and extend their own knowledge Persons interested in commerce would come from countries to the west of America, especially now there were rapid means of communication across the continent from South America, and from other countries, with whom we had the most friendly relations, to say nothing of Canada. It would, therefore, be most unwise for British manufacturers to let any feeling of jealousy or resentment prevent them from showing, in the best possible way, what they could do. To let it be supposed that they were not willing to exhibit because, in some matters, the actual trade relations between the United Kingdom and America were not on the same footing as they were before the passing of the McKinley bill, would be like cutting off one's nose to spite one's face. The way to show that England was in many branches supreme would be to show what we could do in a public-spirited way, even if we did not derive as much pecuniary benefit from it as we otherwise might have done He had received so many kind and pressing invitations from America, that he feared if he went there he should never get back again; and he could not help thinking that from the pleasure and instruction which would be derived—the making of friendships, and drawing closer together ties of friendship already existing, which did so much to cement nations as well as families together—a visit to such an exhibition must be of the greatest

possible advantage, and that any points of difference which might arise from the new tariff were more likely to disappear by free communication than by holding aloof. We might fairly appeal to the commercial and manufacturing interests of the kingdom not to allow the appearance of the old country on such an occasion to be in any way unworthy of what she had done in the past; and he was sure the Society would rejoice if by any means they could aid in making the exhibition a success.

Mr Dredge, in reply, said he thought Sir Henry Wood had scarcely done justice to the hospitable character of the Americans, and the warmth of feeling which seemed to actuate them all where Englishmen were concerned. There were, of course, some ignorant people who looked on Englishmen as their mortal enemies, but on the whole it would be difficult to find a single intellectual American who was not willing to come three-quarters of the way across the Atlantic with outstretched hands to meet us if we would go the other quarter. Mr Jeans spoke very justly about the difficulty there would be in inducing iron and steel manufacturers to exhibit; it was most unlikely that they would do so unless they were interested in some special branch, for the simple reason that the majority of them knew that we were far behind Americans in the same line of business. They had larger outputs, and more efficient processes for making a large output, and we should have to learn from them rather than teach. Mr. Jeans had spoken with some warmth from his personal experience of the custom house difficulties; but he advised him, next time he took the responsibility of personally conducting 400 or 500 Englishmen on a visit to America, to insist on them not carrying hat boxes, for he believed they caused all the trouble. Two or three reception committees informed him that they did not mind any amount of trouble, and could deal with any amount of luggage, but when they saw a row of four hundred hat boxes, it flattened them out completely. Sir Frederick Bramwell had referred to the qualities of energy, determination, and so forth as a source of success to an exhibition, and certainly those qualities were more concentrated in Chicago than in any other city. He was sorry Mr. Kohlsaat had not given them more information, as he might have done, being a member of the exhibition executive; for he had that morning showed him a telegram from the president and vice-president stating that the United States Commission had fully approved the plans which had been prepared, the sites, and financial position, and were about to recommend the President of the United States to issue the proclamation inviting all foreign nations to contribute. It had come to his knowledge that China and Japan intended to be represented on a scale they had not hitherto attempted. This was not surprising in the case of Japan; but the intention of China to come forward in this way was very significant, being another proof of her intention to break down the barriers which separated her from the western world; so that she would become, in the near future, one of the most valuable foreign markets. The South American republics had also announced their intention of exhibiting on as large a scale as in Paris. Possible exhibitors would not require to decide for some months to come, and if this paper supplied them with any material for preliminary consideration, he should be amply repaid.

The chairman, in proposing a vote of thanks to Mr. Dredge, expressed the hope that when the scheme was more matured, a further paper, giving more detailed information, might be prepared and read.

The vote of thanks was carried unanimously, and the proceedings terminated.

RECOVERING TIN FROM TIN PLATE SCRAP.

By B. SCHULTER.

THE solvent action of acid ferric salts upon metals is well known, but the property has not hitherto been utilized in the treatment of tin plate waste, for which purpose it answers perfectly. The solvent used may be either acid ferric sulphate, acid stannic sulphate, dilute sulphuric acid, or dilute hydrochloric acid, but in the two latter cases ferric hydrate, in the form of heavily rusted scrap iron, must be added. The tin, when dissolved, is precipitated by metallic iron, for which purpose, however, the solution must be perfectly neutral, and contain only protoxide salts, as the smallest excess of acid in the presence of persalts prevents the reaction. This condition is obtained by passing the solution through a mixture of iron rust, metallic tin, and metallic iron, when the following reactions take place:

1. $Fe_2O_3 3H_2O + Sn O SO_3 + 3 SO_3 H_2O = 2 Fe O SO_3 + Sn O_2 2 SO_3 6 H_2O$.
2. $Sn O_2 2 SO_3 + Sn = 2 Sn O SO_3$.
3. $2 Sn O SO_3 + 2 Fe = 2 Fe O SO_3 + 2 Sn$.

The process, as practiced, includes three principal operations:

1. The solution of the tin.
2. The precipitation of the tin.
3. The treatment of the waste liquor.

When acid ferric sulphate is used the tin plate cuttings are placed in iron baskets and lowered into the solution contained in an open wooden vat. The tin covering is completely stripped off the iron in a very few hours. The basket is then lifted out, the contents washed in water and picked over by hand to separate portions still covered with tin, while the remainder, which is clean malleable iron, is pressed into balls for the heating furnace.

The partially stripped portions are either returned to the dissolving bath or put aside to rust, in order to obtain material for the neutralizing vat.

When the solution is saturated, as evidenced by its no longer acting upon fresh tin plate scrap, in which condition it contains mainly stannous and ferrous sulphates, probably a little stannic oxide and some free acid, it is passed to the neutralizing vat containing metallic tin and iron rust, where the excess of acid is neutralized and the persalts are reduced as shown above.

When an acid stannic solution is used, the method of proceeding is similar, the only difference being in the nature of the solvent. Instead of these solutions, dilute sulphuric or hydrochloric acid may be used in conjunction with ferric oxide or its hydrate, but with these the action is somewhat slower, from six to twenty-four hours being required to remove the tin completely.

The precipitation of the tin from the neutral stannous solution is effected by running it into vats containing clean metallic iron (scrap previously freed from tin). The reaction goes on slowly, the tin separating as gray metallic powder or in brilliant crystalline grains; but the reduction is complete, the exhausted solution showing not the slightest trace of tin. The precipitate when washed and cleaned from iron by dilute sulphuric acid, is either melted or used for making tin salts. The green vitriol liquors from the precipitating vats are concentrated by allowing them to drop slowly over a large heap of cleaned iron scrap, which causes a rapid evaporation and a deposit of ferrous sulphate on the metal. This may be washed off and purified as commercial copperas by recrystallizing, or it may be used for forming the acid liquor for dissolving fresh quantities of tin.

When the tin plate cuttings are varnished, the surface is cleaned by heating them with strong sulphuric acid at a temperature of 100° Centigrade, which destroys the varnish in a very short time, leaving the tin surface exposed. When zinc is present, it should first be removed by treatment with dilute sulphuric acid as long as hydrogen is evolved.

The plant and materials required are both simple and inexpensive. From 1 to 6 cwt. of chamber acid, worth from 1s. to 12s., are consumed per cwt. of tin obtained, worth £4 10s. to £5, in addition to 25 to 40 cwt. of iron, worth from £1 17s. to £4. The amount of coal required is inconsiderable. Both tin and iron are obtained in the highest state of purity.—*Dingler's Polytechnische Journal; Chem. Tr. Jour.*

TO CLEAN TOOLS AND MACHINERY.—To clean iron parts of machinery, tools, etc., about 10 grammes of paraffin chipped fine, are added to one liter petroleum in a stoppered bottle, and during two or three days from time to time shaken up until the paraffin is dissolved. To apply it the mixture is well shaken, spread upon the metal to be cleaned by means of a woolen rag or brush, and on the following day rubbed off with a dry woolen rag.

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